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NATIONAL DAM SAFETY PROGRAM. ESHBAUGH-MARTIN DAM NO NAME 550 (M--ETC(U)
AUG 79 K B KING, J H GRAY, D E WESTCOTT DACW43-79-C-0037

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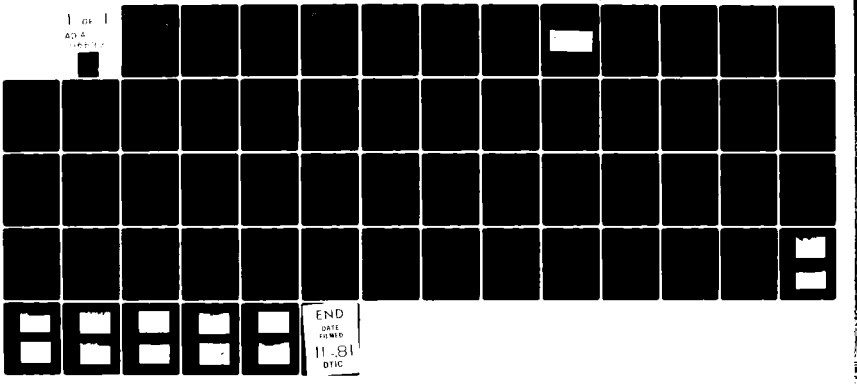

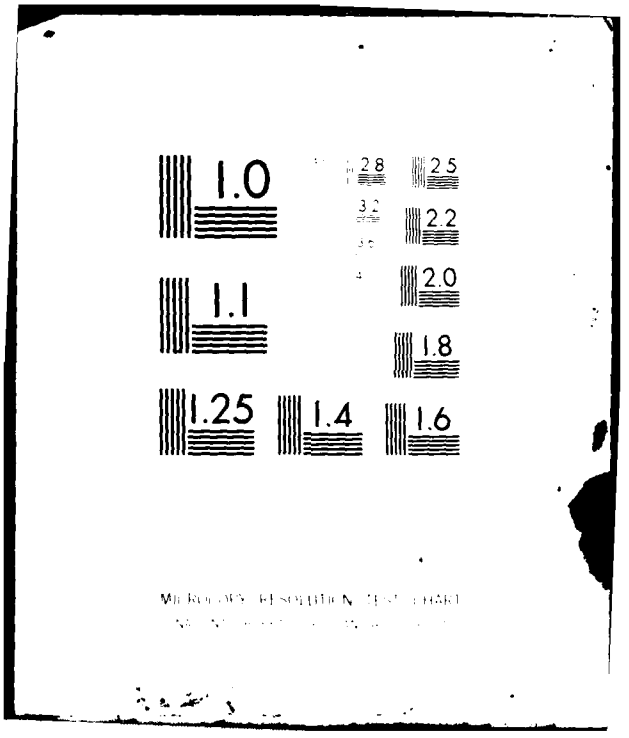
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MISSISSIPPI-KASKASKIA-ST. LOUIS BASIN

LEVEL II

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NO NAME 550 DAM
WASHINGTON COUNTY, MISSOURI
MO 30711

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
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St. Louis District

PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

AUGUST 1979

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: No Name 550 Dam (MO 30711) Phase I Inspection Report

This report presents the results of field inspection and evaluation of the No Name 550 Dam. It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY: SIGNED
Chief, Engineering Division

31 MAR 1980
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

1 APR 1980
Date

NO NAME 550 DAM
WASHINGTON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30711

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY

INTERNATIONAL ENGINEERING COMPANY, INC.
CONSULTING ENGINEERS
SAN FRANCISCO, CALIFORNIA

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

AUGUST 1979

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	No Name 550 Dam
State	Missouri
County	Washington
Stream	Unnamed Tributary to Big River
Date of Inspection	18 April 1979

No Name 550 Dam, I.D. No. 30711, owned by Mr. Norman Eshbough of Imperial, Missouri, and Mrs. Ed Martin of DeSoto, Missouri, was inspected by a civil engineer and an engineering geologist from International Engineering Company, Inc. of San Francisco, California. The purpose of the inspection was to assess the general condition of the dam with respect to safety. The assessment is based on an evaluation of the available data, a visual inspection, and an evaluation of the hydrology and hydraulics of the site to determine if the dam poses hazards to human life or property. The dam provides impoundment for barite ore tailings. The impoundment is inactive.

No Name 550 Dam was inspected using the "Recommended Guidelines for Safety Inspection of Dams" furnished by the Department of the Army, Office of the Chief of Engineers. Based on these Guidelines, this dam is classified as being of large size. The St. Louis District Corps of Engineers has classified this dam to have a high downstream hazard potential. Failure of this dam could threaten life and property. The estimated damage zone provided by the St. Louis District Corps of Engineers extends approximately fifteen miles downstream of the dam. There are 25 dwellings, a campground, and five bridges within this damage zone.

The results of the inspection and evaluation indicate that the spillway does not meet the criteria given in the Guidelines for a dam with the size and hazard potential of No Name 550 Dam. As a large size dam with a high hazard potential, the Guidelines specify that the discharge capacity and/or storage capacity should be capable of safely handling the Probable Maximum Flood (PMF) without overtopping the crest. The PMF is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

It is calculated that the spillway can pass a 100-year flood (~~a~~ flood having a 1 percent chance of being equalled or exceeded in any 1 ~~year~~) without overtopping the dam. It was also estimated that the spillway could pass 90 percent of the PMF without overtopping the dam and without significant erosion of the embankment. However, flows greater than 32 percent of the PMF would cause significant erosion of the wing dam constriction. Significant erosion of the spillway and wing

dam will not result in failure of the embankment. Moreover, overtopping of the dam crest between Stations 23+00 and 38+00 is more likely to result in embankment failure.

Adequate overflow facilities and freeboard should be provided so that the impoundment can handle the PMF without overtopping the crest and without significant erosion of the embankment or spillway. The strip-mined area downstream of the spillway requires further hydrologic study to determine whether any downstream hazard is created by spillway discharges.

Gravel has been mined from the dam crest. This has the effect of reducing available freeboard and the dam's ability to retain runoff. This is a deficiency which should be corrected.

Seepage and stability analyses of this dam are not available. These studies should be performed by a professional engineer experienced in the design and construction of tailings dams and should be made a matter of record. Based on the results of these analyses, remedial measures may become necessary. Remedial work should be performed under the direction of an engineer experienced in the design and construction of tailings dams.

An inspection and maintenance program should be initiated. Periodic inspections should be made and documented by qualified personnel to observe the performance of the dam and spillway.

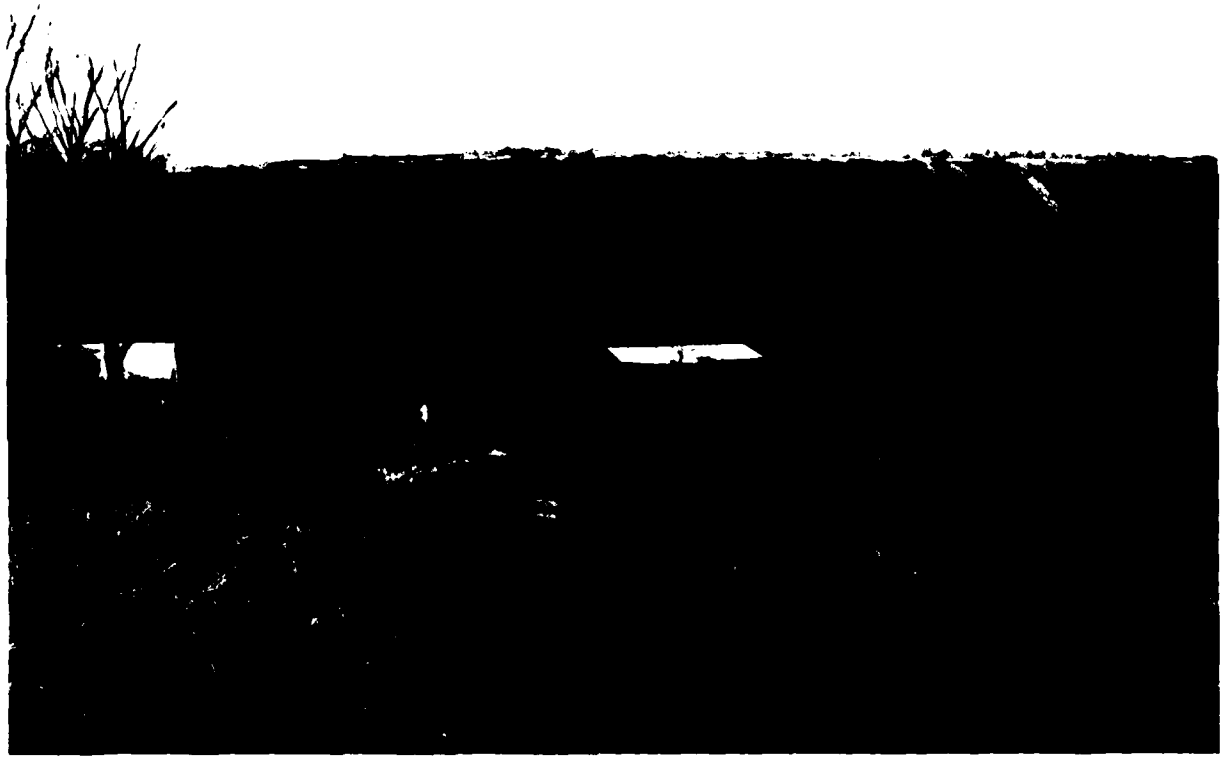
A plan to permanently drain the impoundment and safely reclaim the site could be developed and implemented under the direction of qualified personnel as an alternative to the remedial measures recommended for the dam.

It is recommended that the owner take action to correct the deficiencies described.

Kenneth B. King, P.E.

James H. Gray, P.E.

Donald E. Westcott



OVERVIEW OF NO NAME 550 DAM I.D. No.30711

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NO NAME 550 DAM
I.D. NO. 30711

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PHOTOGRAPHS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NO NAME 550 DAM - ID NO. 30711

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspections of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of the No Name 550 Dam be made.

b. Purpose of the Inspection. The purpose of the inspection was to assess the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams." These Guidelines were developed with the help of several Federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) Type of dam - No Name 550 Dam is an earthfill dam that was used to impound barite ore tailings. The impoundment is formed by an incomplete ring dam.

(2) Spillway - The spillway is located at the right abutment. Outflow passes around the end of the main dam in a swale adjacent to the dam, through a constriction formed by the end of the wing dam and right abutment, and into a strip-mined area adjacent to the southeast side of the impoundment.

b. Location. The dam is located in Washington County, Missouri, as shown in Plate 1. The dam is shown in Plate 2 and is located in Section 26, Township 39 North, Range 3 East.

c. Size Classification. No Name 550 Dam is greater than 100 feet high and therefore is classified as a large size dam in accordance with "Recommended Guidelines for Safety Inspection of Dams".

d. Hazard Classification. This dam is classified as having a high hazard potential by the St. Louis District, Corps of Engineers. The estimated damage zone, as provided by the St. Louis District, Corps of Engineers, extends approximately fifteen miles downstream of the dam. There are 25 dwellings, a campground and five bridges within this damage zone.

e. Ownership. This dam is jointly owned by:

Norman Eshbough	Mrs. Ed Martin
P. O. Box 51	Route 21
Imperial, Missouri	DeSoto, Missouri

f. Purpose of Dam. The dam impounds tailings that resulted from a barite separation and beneficiation operation. Tailings are no longer conveyed to the impoundment.

g. Design and Construction History. There is no written design or construction data available for this dam. Information obtained from Mr. Gene Williams, General Superintendent of Dresser Minerals, Inc. indicates that the J. E. Carter Company built the dam in 1948, and it was operated by J. E. Carter and subsequently by Dresser Minerals, Inc. until 1969. The site is inactive.

h. Normal Operating Procedures. No operating records are known to exist. Runoff into the pond is removed by spillway overflow, by seepage into the tailings, and by evaporation. The facility is inactive in that tailings are no longer conveyed to the impoundment.

1.3 PERTINENT DATA

a. General. Field surveys were made by Booker Associates, Inc. of St. Louis, Missouri on 27 April 1979. Measurements are valid as of the dates of inspection and survey.

b. Drainage Area. 61 acres (from ASCS air photograph BMH-3MM-255 dated 8-26-71.)

c. Discharge at Damsite.

(1) Outlet Pipe - Not applicable.

(2) Total Spillway Discharge -

(a) Maximum discharge experienced at site - No information available.

(b) Total computed discharge at maximum pool elevation - 360 cfs.

d. Elevation (Feet above M.S.L.)[1/]

(1) Top of dam - variable from 751.0 to 736.0 feet.

(2) Crest at maximum section - 740.0 feet.

(3) Spillway crest - 732.9 feet.

(4) Maximum pool - 736.0 feet.

(5) Impoundment level on 27 April 1979 - 727.8 feet.

(6) Overflow Pipe (invert) - Not applicable.

e. Reservoir.

(1) Length of maximum pool - 1800 feet ± (from ASCS airphoto BMH-3MM-255).

(2) Length of impoundment pool - 500 feet ±.

f. Storage Capacity Above Tailings Surface - 81 acre-feet at El. 736.0 feet.

g. Reservoir Surface Area.

(1) Top of dam (Maximum Pool) - 22 acres at El. 736.0 feet.

(2) Spillway crest - 11 acres at El. 732.9 feet.

(3) Impoundment level - 1.3 acres at El. 727.8 feet.

h. Dam (Main Dam and Wing Dam).

(1) Type - Earthfill

(2) Length of crest - Main dam 3850 feet ±.
- Wing dam 103 feet ±.

(3) Maximum height of dam - Main dam 115 feet ±.
- Wing dam 6 feet ±.

(4) Width of crest - varies from approximately 20 feet to about 90 feet.

1/ Elevations are based on a reference of 742.42 feet M.S.L at the temporary bench mark. This datum was estimated from topographic data presented on the Tiff 7.5-minute Quadrangle Sheet.

(5) Side Slopes -

(a) D/S - Approximately 1V on 1.5H

(b) U/S - Unknown

(6) Zoning - The main dam appears to be constructed consistent with the prevailing barite dam construction practice. The method consists of a clay starter dam enlarged using finer than 7/8-inch gravels. The wing dam is probably constructed using gravels.

(7) Cutoff - There is no written information available to verify that a cutoff was designed or constructed.

i. Spillway.

(1) Type - The spillway is a shallow irregular open channel of asymmetrical triangular cross section.

(2) Control Sections - Broad V-shaped section centered at Station 0+35 at end of dam. At higher flows, control shifts approximately 560 feet downstream to a V-shaped constriction located at the end of the wing dam.

(3) Crest elevation - El. 732.9 feet (control section).
El. 729.9 feet (Wing Dam constriction).

(4) Upstream Channel - None.

(5) Downstream Channel - 560-foot long channel (measured from upper control point) which passes through a constriction and then flows 250 feet unchanneled into an 4-1/2 acre area beside the dam where outflow would collect. There is no outlet from this area.

j. Outlets. Not applicable.

k. Diversion Ditches. Not applicable.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design drawings or data are known to exist.

2.2 CONSTRUCTION

a. Information. The dam was built in 1948 by the J. E. Carter Company. There are no records concerning construction methods, materials, or procedures.

b. Assessment of Construction Method and Materials. Procedures used to build this dam were developed by miners using trial and error techniques over the last 60 years. After construction of the starter dam, sand and angular gravels (finer than 7/8-inch) were hauled to the crest of the dam, end-dumped, and spread; and excess material was pushed over the upstream and downstream faces of the dam. The sands and gravels placed in this manner are in a loose state and are at their natural angle of repose on the downstream face. The material pushed over the upstream side rests on the tailings. The centerline of the dam remains approximately at the same position as the embankment is raised. Compaction of the material on the crest was by construction equipment.

The minus 7/8-inch gravels were used to enlarge this tailings dam. They are free draining, angular, and relatively well-graded through the gravel and coarse sand range. The gravel appears to function well as a drain material, and it also functions fairly well as erosion protection from rainfall; however, it is inadequate to prevent erosion from channeled surface flow with a velocity greater than 4 to 6 feet per second.

Foundation preparation for the downstream foundation zone appears to be nonexistent, as buried trees in the downstream face tend to indicate.

2.3 OPERATION

The impoundment was operated from 1948 by J. E. Carter and subsequently by Dresser Minerals, Inc. until 1969. No records of operation are known to exist.

2.4 EVALUATION

a. Availability. No design or construction records were available. The only information made available to the inspection team was provided during conversations with Mr. Norman Eshbough, the present co-owner, and by Mr. Gene Williams, General Superintendent of Dresser Minerals, Inc., former owner of the facility.

b. Adequacy. The field surveys and visual inspections documented herein are considered adequate to support the conclusions of this report. Seepage and stability analyses comparable to the requirements of "Recommended Guidelines for the Safety Inspection of Dams" are not available; the lack of these analyses is considered to be a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions, including earthquake loads, and should be made a matter of record.

c. Validity. Not applicable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. The inspection team consisted of a civil engineer and an engineering geologist from International Engineering Company, Inc. Mr. Norman Eshbough authorized the inspection during a telephone conversation with the inspection team. The impoundment is a barite tailings pond located in an abandoned barite strip mine. Photographs taken during the inspection are included in this report. Photograph locations are shown on Plate 8.

b. Project Geology. Bedrock in the area and underlying the dam is composed of the gray dolomite of the Cambrian age Potosi formation. Isolated outcrops are found over much of the surrounding area; these outcrops have been exposed by mining activities. An east-west trending fault occurs within 1000 feet of the toe of the dam from Station 27+00 to Station 36+00. Information obtained from the State of Missouri contains no record of historic seismic activity associated with this fault. No evidence that would indicate recent movement of this fault was observed near the damsite. Thinly bedded sandstone outcrops were observed in a stream channel about 900 feet north of the dam. Soil cover ranges from about 0 to 15 feet in thickness. The residual soil consists of dark red and brown barite rich clays. Intermixed with the clays are rock fragments consisting of barite, quartz, chert and dolomite which grade from sand to boulders.

c. Dam. The plan of the dam is shown on Plate 3. Profiles and sections are shown on Plates 4, 5, 6, and 7. A little vegetation is growing on the slopes of the dam. Some trees were buried during the dam enlargement process, and these were exposed in places on the downstream slope of the dam.

No detrimental settlement, depressions, sinkholes, instability, or evidence of past embankment overtopping was observed at the dam.

Evidence of past gravel mining was observed near Stations 24+00 to 26+00 on the upstream crest, between stations 36+30 to 38+90 on the upstream crest, and on the downstream slope near the left abutment between Stations 40+50 and 43+00. Some of the gravel mining activity may have occurred recently. Tailings are exposed in crest excavations near Stations 25+00 and 37+00.

The low spot on the dam crest appears to be between Stations 36+50 to 38+50, where the dam crest has been excavated, leaving exposed tailings and no available freeboard above the tailings.

The last 10 feet of embankment height between Stations 22+00 and 37+00 appears to be constructed by the upstream method. Two distinct crests were observed, and tailings were observed in the base of a gravel excavation near Station 24+70 on the upper crest.

The exposed ground below the foundation of the dam near Stations 24+00 to 27+00 is sloping at approximately 20 percent in a downstream direction. Review of the USGS 7.5-minute Tiff Quadrangle dated 1937 indicates that the original ground underneath the embankment slopes approximately 20 percent in a downstream direction. An interpretive section at Station 26+00 is shown on Plate 9.

A spring was flowing from the dam toe Station 28+28 into the original stream channel at 40 gpm and clear. A seep at Station 29+00 was flowing clear at approximately 1 gpm. Seepage was observed along the dam toe in a captured drainage near Station 32+00 at 5 gpm and clear. The ground condition at seepage locations was relatively firm due to locally shallow soil cover.

There is no slope protection provided on the embankment slopes. Two animal burrows were observed on the lower dam crest at Station 29+20. One burrow was measured to be at least 5 feet deep.

The left abutment is located at Station 43+59 and consists of residual soil. Strip mining activity has occurred at this abutment. The right abutment is located at station 0+69 of the dam and at the end (Station 1+03) of the wing dam. The abutment consists mostly of unmined residual soil, although some strip mining activity has occurred near the end of the wing dam.

d. Appurtenant Structures. The spillway is located by the southeast corner of the dam at the right abutment. Outflow from the impoundment passes around the end and then parallel to the dam (Station 0+69 to 6+00) through a flat sloped swale on undisturbed ground covered with grasses and some brush. A control section of this channel is located at the dam baseline with the invert at Station 0+35. The embankment from Stations 0+69 to 5+50 also functions as an overflow structure at higher reservoir elevations. The embankment between these stations was constructed of coarse gravel (plus 7/8-inch) and plus 4-inch sized rock. Information obtained from a 1971 airphoto enlargement indicates that this section of the embankment was a decant structure which separated the makeup water collection area from the tailings pond. The spillway channel section is sharply constricted approximately 560 feet downstream from Station 0+45 where it passes around the end (Station 1+03 of wing dam baseline, Plate 6) of a small wing dam constructed of gravel and rock. Outflow past the constriction then collects a strip-mined area partially filled with tailings adjacent to the dam. This area extends approximately from Station 6+50 to Station 14+00.

An inactive 12-inch diameter pipe from the mill site enters the embankment at Station 20+60 and extends along the crest in broken sections to Station 25+00. Location of this line is shown on Plate 3. No diversion ditches are located at the damsite.

e. Reservoir Area. No landslide activity or excessive erosion was observed in the reservoir area. Little sedimentation occurs at this

site because of the small drainage basin, and there are no upstream structures that might be subject to backwater flooding.

The impoundment contains red silty clays that were deposited by hydraulic methods during active mine operations. No deposition has occurred for approximately 10 years. Some consolidation of the tailings has probably occurred, primarily in the immediate area adjacent to the dam where the tailings can drain. Also, the surface zones have desiccated, and small trees and grasses transpire some water from near the surface of the tailings.

Approximately 60 percent of the watershed area is old tailings covered by small trees and grass. Undisturbed forest comprises about 40 percent of the watershed.

f. Downstream Channels. The area immediately downstream of the spillway constriction has been strip-mined and partially filled with tailings. Outflow from the spillway would accumulate in this collection area. This collection area adjacent to the dam appears to form a closed drainage basin defined by the dam and an access road. If water overtopped the access road defining the eastern boundary of this collection area, it could flow southeasterly through a disturbed drainage tributary to Big River.

The original drainage channel is located at Station 28+60 and flows northeasterly for one-half mile into Big River. It is a narrow, densely vegetated, V-shaped channel. Significant discharges from the dam probably would not enter this channel unless the west side of the dam was overtopped.

3.2 EVALUATION

Gravel mining activities have reduced the crest elevations available and storage capacity of the dam.

Evidence of steep (20 percent) downstream foundation slopes under embankment Stations 24+00 to 27+00 was indicated by field observations and a review of original topographic data presented in the 1937 USGS 7.5-minute Tiff Quadrangle. Further study of embankment stability in this area is needed to determine the magnitude of this potential problem.

The last 10 feet of embankment height were apparently constructed by an upstream method used between Stations 23+00 and 37+00. Tailings underlying embankment material were observed at the base of excavation at Station 24+70. This situation should be evaluated during stability analysis.

The embankment is a relatively porous granular structure above the tailings surface. If the water level were to rise above the tailings surface due to flood runoff, there could be significant seepage through the embankment which may have an adverse effect on the stability of the dam.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

No regulating procedures exist for the structure. An uncontrolled spillway is the only means of passing runoff water from this dam.

4.2 MAINTENANCE OF DAM

Information available to the inspection team indicates that the dam is not maintained. Gravel has been excavated from the embankment crest.

4.3 MAINTENANCE OF OPERATING FACILITIES

Not applicable.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

To our knowledge there is no warning system in effect at this dam.

4.5 EVALUATION

A periodic inspection program should be initiated so that indications of instability, such as cracks in the dam, sloughing, sudden settlement, erosion of the dam, or an increase in the volume or turbidity of water from the springs or seeps, can be monitored. Maintenance of the dam is inadequate, and the excavation of gravel from the embankment should cease immediately.

SECTION 5 - HYDRAULIC AND HYDROLOGIC ANALYSES

5.1 EVALUATION OF FEATURES

a. Design Data. The significant dimensions of the dam and spillway and the wing dam are presented in Section 1 - Project Information and are also presented in the accompanying field survey drawings, Plates 3 through 7. No hydrologic or hydraulic design information is available.

For this evaluation, the watershed drainage area was measured on a USGS 7.5-minute quadrangle map and the reservoir areas were obtained from the 1971 ASCS 1 inch = 660 feet scale aerial photograph enlargement. The soil group for this watershed is classified as Clarksville Gravelly Loam, equivalent to a hydrologic soil group B classification, which has a moderate rate of water transmission.

The drainage area, as shown on Plate 2, is approximately 61 acres (0.095-square mile). Land use and the vegetation pattern in the watershed were determined from field observations and aerial photographs of the project area, divided approximately into the following categories.

Type of Cover	Percent of Watershed
Old Tailings	56
Undisturbed Forest	44

Based on the above, the estimated curve numbers weighted for the entire watershed are CN 56 for the AMC II condition and CN 75 for the AMC III condition.

The basin parameters such as basin lag time, unit hydrograph, the probable maximum precipitation and antecedent moisture condition assumptions are presented in Appendix A.

The local drainage area between the spillway and the wing dam is only about 3 acres. Runoff from this area was estimated assuming a lag time of 5 minutes and a runoff curve number of 100.

The spillway is described in detail in Section 3. This collection area is in effect a closed drainage with no observed outlet. The invert elevation of the spillway and the constriction are at El. 732.9 and El. 729.9, respectively. The minimum dam crest elevation is 736.0 located at Stations 36+50 to 38+50 where gravel has been excavated from the dam crest.

Computations of the discharge rating curve for flows over the spillway and the dam crest were made by using the weir formula with a weir coefficient of C = 2.7 for elevations lower than 734.5 and 3.0 for higher elevations and above the dam crest. The combined discharge rating curve for flows in the spillway and over the dam crest is shown in Appendix A, under the input data listing as Y4 and Y5 cards, and also in the computer printout. The discharge rating curve for the constriction at the wing dam was computed by using the weir formula with a weir coefficient of C = 2.7.

Storage capacity below El. 725 is considered to be tailings storage. The reservoir elevation area-capacity data are shown in Appendix A. The capacities, as computed in the computer program by the Conic Method, are the relative capacities above the minimum elevation (El. 725.0). An approximate water surface elevation-capacity relation was derived to account for the wing dam storage effect and entered as input for secondary routing through the constriction at the wing dam.

b. Experience Data. Recorded rainfall, runoff, or other experience data are not available.

c. Visual Observations. Visual observations are described in Section 3 - Visual Inspections.

d. Overtopping Potential. An analysis on the overtopping potential was made using the following procedure:

- The 100-year flood, probable maximum flood (PMF), and floods expressed as a percent of the PMF were computed and routed through the reservoir and spillway using the discharge rating curve for the spillway.

- The routed outflows from the above were routed through the constriction at the wing dam after combining the local runoff from the area between the spillway and the wing dam. Results indicate that there is backwater effect in the spillway for floods larger than 30 percent of PMF when the stage of the reservoir reaches elevation 735.0 or higher.

- For floods larger than 30 percent of PMF, the spillway discharge rating curve was modified beyond El. 735 by using the discharge at the the wing dam constriction. A new discharge rating curve for flows in the spillway, combining with the flow over the dam crest, was obtained. The floods were then routed through the reservoir to determine the overtopping potential.

The PMF is defined as the hypothetical flood event that would result from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible at a particular location or

region. The Modified Puls Method was used for flood routing. For all cases of flood routing, the initial water level of the reservoir was set at the spillway invert elevation, El. 732.9. It was assumed that erosion of the earth channel and spillway-wing dam sections will not occur as flood discharges increase. Therefore, the spillway discharge rating curve was computed for a specific cross-section and configuration.

Results of the overtopping analyses indicate that the spillway is able to pass the 100-year flood. Routing studies indicate that the spillway can also pass 90 percent of the PMF without overtopping the embankment. At 90 percent PMF, the peak spillway outflow is 360 cfs, with a flow depth of 6.1 feet and flow velocity of about 6.3 feet per second through the constriction at the wing dam. The corresponding flow depth at the spillway is 3.1 feet with a flow velocity of 4.9 feet per second. High discharge velocities such as those at 90 percent PMF peak outflow would cause significant erosion of the constriction at the wing dam. At the PMF, almost all of the outflow passes through the spillway. The peak outflow overtopping the dam at the minimum dam crest during the PMF is estimated to be about 10 cfs. The remainder of the total 426 cfs peak outflow passes through the spillway.

A major consideration in evaluating the safety of the dam is assessing the potential for erosion failure of the embankment as a result of overtopping or spillway discharges. Since the spillway is composed of erodible materials, high velocity discharges through the spillway will lead to significant erosion of the spillway and wing dam even if the dam is not overtopped. Based on the Corps of Engineers Manual EM 1110-2-1601, "Hydraulic Design of the Flood Control Channels", the maximum permissible mean velocity for the grass-covered residual soil and gravel fill materials found in the spillway section and the constriction at the wing dam is estimated to be about 5.0 feet per second. Using this as a criterion, the constriction at the wing dam can pass about 32 percent of the PMF without significant erosion. The 32 percent PMF routed outflow is 110 cfs, with a flow depth of 3.8 feet at the constriction.

An evaluation of site conditions indicates overtopping of the dam crest is more likely to result in embankment failure than failure resulting from erosion. Significant erosion in the spillway and wing dam constriction would probably not result in embankment failure. The primary effect of overtopping would be an increased flow of water into the embankment gravels and into a captured drainage channel at the dam toe. This flow would probably cause significant erosion and movement of embankment gravels at the toe of the dam where the water would exit.

The results of the overtopping analyses are reported in Appendix A and summarized on the following page.

Flood	Peak Inflow (cfs)	Peak Outflow (cfs)	Max. Res. WS Elev. (ft)	Spillway Flow Depth (ft)	Velocity in Spillway (ft/sec)	Duration Velocity Over 5 ft/sec (hr)
	Main Dam Control Section					
30% PMF	407	84	734.5	1.6	3.4	0
50% PMF	678	238	735.1	2.2	4.1	0
60% PMF	813	273	735.3	2.4	4.3	0
80% PMF	1085	333	735.8	2.9	4.7	0
90% PMF	1220	360	736.0	3.1	4.9	0
PMF	1356	426	736.2**	3.3*	5.1*	0.5

Flood	Peak Inflow (cfs)	Peak Outflow (cfs)	Max. Res. WS Elev. (ft)	Constriction Flow Depth (ft)	Velocity in Constriction (ft/sec)	Duration Velocity Over 5 ft/sec (hr)
	Wing Dam Constriction					
30% PMF	407	84	734.5	3.5	4.8	0
50% PMF	678	238	735.1	5.2*	5.8*	2.7
60% PMF	813	273	735.3	5.4*	5.9*	10.3
80% PMF	1085	333	735.8	5.9*	6.2*	11.6
90% PMF	1220	360	736.0	6.1*	6.3*	12.8
PMF	1356	426	736.2**	6.3*	6.4*	13.7

* These flow depths and velocities are considered to produce the effects for significant erosion. The effects of significant erosion are assumed as not resulting in failure of the embankment.

** Dam overtopped (Minimum Dam Crest, El. 736.0).

Note: Reservoir water surface elevations include the velocity heads corresponding to the velocities computed at the various flow depths for the spillway section and sections over the minimum dam crest.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions that may adversely affect the structural stability of this dam are discussed in Section 3.

b. Design and Construction Data. No design or construction data pertaining to the structural stability of the dam were available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, and lack of this information is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions, including earthquake loads, and made a matter of record.

c. Operating Records. No appurtenant structures are operable at this dam; no records of operations were located.

d. Post-Construction Changes. The dam has been enlarged during active mine operations, but no records are available concerning dates of enlargements, design, or materials used. Gravel has been excavated from the embankment crest and from the downstream slope after abandonment of barite tailings disposal operations.

e. Seismic Stability. The dam is located in Seismic Zone 2, to which the 1976 Uniform Building Code assigns a "moderate" damage potential. There appears to be a potential for instability caused by ground shaking during earthquakes where the dam rests on unprepared foundation material having a steep downstream slope. Some crest settlement and ravelling of the embankment gravels could also occur during seismic shaking because the downstream slope is at or near the natural angle of repose of the gravel.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several deficient conditions at the dam should be corrected to improve the margin of safety. Inadequate freeboard resulting from gravel mining activities is the most serious deficiency. Other deficiencies noted are: inadequate spillway capacity and erosion protection and excessively steep slopes resulting from mining of embankment gravels at the toe. Suggested remedial measures are discussed in Section 7.2, REMEDIAL MEASURES.

b. Adequacy of Information. No design or construction data were available. Seepage and stability analyses meeting the requirements of "Recommended Guidelines for the Safety Inspection of Dams" were not available. This lack of information is considered a deficiency.

Topographic data for this dam are inadequate. This is due to the fact that the dam construction and the mining activity occurred subsequent to the publication of the USGS 7-1/2-minute quadrangle map. The drainage area was measured after the dam was located on the original topography. Reservoir area capacity data and slopes were developed using survey measurements and constructing topographic contours on a 1 inch = 660 feet air photo enlargement showing the reservoir and watershed areas. This data is considered to be adequate for a Phase I analysis; however, the evaluation of overtopping potential is approximate due to the available data.

c. Urgency. The inadequate spillway capacity and reduction of effective freeboard by mining gravel from the crest are significant deficiencies. Corrective measures to restore freeboard and provide adequate spillway capacity should be initiated in the near future.

d. Necessity for Phase II. No Phase II investigation is required, however, additional studies recommended for this dam are seepage and stability analyses or a reclamation plan as described below in Section 7.2. Seepage and stability analyses meeting the requirements of "Recommended Guidelines for the Safety Inspection of Dams" were not available, which is considered a deficiency. The strip-mined area downstream of the spillway requires further hydrologic study to determine whether any downstream hazard is created from spillway discharges.

7.2 REMEDIAL MEASURES

a. Spillway. The spillway should be designed or modified to safely pass the PMF without causing erosion of the spillway or embankment under the Guidelines established by the Corps of Engineers. An engineer experienced in the design of dam spillways should be retained to direct the design and construction of the spillway.

b. Increase in Freeboard. The practice of excavating gravel from the embankment crest, particularly near Station 36+50 should cease immediately. This excavated area should be refilled with similar materials to increase freeboard at the low spot of the dam crest.

c. Inspection Program. The dam should be inspected periodically by an engineer who will observe and record the performance of the dam. The springs and seeps should be monitored as part of the inspection program. Records of these inspections should be maintained, and all maintenance or remedial measures performed at the site should be documented.

d. Modification of Slopes. The excessively steep downstream slope near Station 42+00 should be regraded to flatten the slope where past gravel mining at the toe has occurred.

e. Stability and Seepage Analyses. These analyses should be performed by an engineer experienced in the design and construction of tailings dams. The effect of the foundation slope on stability of dam sections between Stations 24+00 and 29+00 should be evaluated. Also, the upstream construction method used to raise the embankment to its final height should be considered in the stability analysis. The embankment is a relatively porous granular structure above the tailings surface. If the impoundment water level were to rise above the tailings surface, there could be significant seepage through the embankment which could adversely affect the stability of the dam. Included in these analyses, therefore, seepage and stability computations should also be performed with the reservoir water surface set at the top of the dam. Based on the results of these studies, remedial measures may be necessary. Remedial work should be done under the direction of an engineer experienced in tailings dam design and construction.

f. Deactivation of Impoundment. As an alternative to the above remedial measures, a plan to permanently drain the impoundment and reclaim the embankment and tailings pond could be developed. Such a plan should make provisions for the safe removal of storm runoff and maintain the stability of the dam and impounded tailings at all times. Preparation of a reclamation plan and reclamation activities should be accomplished under the direction of an engineer experienced in the design and construction of tailings dams.

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSES

The hydrologic and hydraulic analyses were accomplished by using the computer program "Flood Hydrograph Package, HEC-1, Dam Safety Investigations Version, July 1978". This program was developed by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The criteria and methodology used are briefly discussed below:

- Probable Maximum Precipitation (PMP) - The 24-hour PMP was obtained from Hydrometeorological Report No. 33. The 6-hour and the 1-hour depth-duration distributions followed Corps of Engineers EM 1110-2-1411 criteria.

- 100-year and/or 10-year storms - The 24-hour storm amounts and distributions were supplied by Corps of Engineers, St. Louis District, Missouri.

- Unit Hydrograph - The Soil Conservation Service (SCS) curvelinear unit hydrograph method was used. Basin lag time was computed by using the SCS Curve Number Method and equation.

- Hydrologic Soil Group, Antecedent Moisture Condition (AMC) and Curve Number (CN) - The predominant hydrologic soil group for the watershed was obtained from an agricultural soil classification map prepared by the University of Missouri Agricultural Experiment Station. For the PMF and floods expressed as a percent of PMF, AMC III conditions were used. For the 100-year and/or 10-year floods, AMC II conditions were assumed. Watershed CN was estimated from field observations and from aerial photos.

- Reservoir Area-Capacity - Areas were measured from A.S.C.S. air photograph enlargements. Reservoir elevations and corresponding surface areas were input into the computer program, which determined the reservoir capacities by the Conic Method.

- Reservoir and Spillway Flood Routing - The Modified Puls Method was used for all flood routing through spillway and dam overtopping analyses.

The following pages present the input data listing, the computer program version and its last modification date, together with pertinent computer printouts of results. Definitions of all input and output variable names are presented in the computer program "Users Manual", September 1978, and are not explained herein.

```
A1          NO NAME 550 DAM ID # 30711
A2          HEC-1 PHASE I DAM SAFETY INVESTIGATIONS
A3          RATIOS OF PMF ROUTED THROUGH RESERVOIR
B     288                   5
B1      5
J       1         6         1
J1    0.3       0.5       0.6       0.8       0.9       1.0
K       0    INFLOW                             1         1         1
K1   INFLOW FROM DRAINAGE AREA ABOVE DAM ID # 30711
M       1         2     0.095                              1                   1
P       0      25.7       102       120       130
T                                                                -1       -75                .50
W2              0.1
X     -10       -.1       2.5
K       1      POND                               1         1         1
K1   ROUTING THROUGH RESERVOIR OF DAM ID # 30711
Y                                          1         1
Y1      1                                                    -732.9        -1
Y4    725     732.9     734.1     734.5     734.7       735       736       737       738
Y5      0     0.001        48        90       125       230       360       750      1500
$A      0       1.5        12        22        34
$E    725       728       733       736       740
$$  732.9
$D    736
K      99
A
A
A
A
A
```

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********************************

RUN  DATE= 79/08/15.
     TIME= 13.12.12.
```

NO NAME 550 DAM ID # 30711
HEC-1 PHASE 1 DAM SAFETY INVESTIGATIONS
RATIOS OF PMF ROUTED THROUGH RESERVOIR

JOB SPECIFICATION

NW	NMR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
284	0	5	0	0	0	0	0	0	0

JOPER	NRT	LRUPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 6 LRTIO= 1

RTIOS= .50 .60 .80 .90 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW FROM DRAINAGE AREA ABOVE DAM ID # 30711

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
INFLOW		0	0	0	1	1	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.10	0.00	.10	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.70	102.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LRDPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-75.00	0.00	.56

CURVE NO = -75.00 WETNESS = -1.00 EFFECT CN = 75.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .10

RECESSION DATA
STRTQ= -10.00 QRCSN= -.10 RTIOR= 2.50

TIME INCREMENT IN LAG/CLARK-(NHR) IS 01 LAG/2)

UNIT HYDROGRAPH 8 END-OF-PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .10 VOL= 1.00

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	.01	.01	3.	1.01	12.05	145	.22	.20	.02	74.
1.01	.10	2	.01	.01	.01	5.	1.01	12.10	146	.22	.20	.01	118.
1.01	.15	3	.01	.01	.01	6.	1.01	12.15	147	.22	.20	.01	138.
1.01	.20	4	.01	.01	.01	6.	1.01	12.20	148	.22	.21	.01	146.
1.01	.25	5	.01	.01	.01	6.	1.01	12.25	149	.22	.21	.01	149.
1.01	.30	6	.01	.01	.01	6.	1.01	12.30	150	.22	.21	.01	151.
1.01	.35	7	.01	.01	.01	6.	1.01	12.35	151	.22	.21	.01	152.
1.01	.40	8	.01	.01	.01	6.	1.01	12.40	152	.22	.21	.01	152.
1.01	.45	9	.01	.01	.01	6.	1.01	12.45	153	.22	.21	.01	153.
1.01	.50	10	.01	.01	.01	6.	1.01	12.50	154	.22	.21	.01	153.
1.01	.55	11	.01	.01	.01	6.	1.01	12.55	155	.22	.21	.01	153.
1.01	1.00	12	.01	.01	.01	6.	1.01	13.00	156	.22	.21	.01	154.
1.01	1.05	13	.01	.01	.01	6.	1.01	13.05	157	.26	.25	.01	163.
1.01	1.10	14	.01	.01	.01	6.	1.01	13.10	158	.26	.25	.01	176.
1.01	1.15	15	.01	.01	.01	6.	1.01	13.15	159	.26	.25	.01	182.
1.01	1.20	16	.01	.01	.01	6.	1.01	13.20	160	.26	.25	.01	184.
1.01	1.25	17	.01	.01	.01	6.	1.01	13.25	161	.26	.25	.01	185.
1.01	1.30	18	.01	.01	.01	6.	1.01	13.30	162	.26	.25	.01	186.
1.01	1.35	19	.01	.01	.01	6.	1.01	13.35	163	.26	.25	.01	187.
1.01	1.40	20	.01	.01	.01	6.	1.01	13.40	164	.26	.25	.01	187.
1.01	1.45	21	.01	.01	.01	6.	1.01	13.45	165	.26	.25	.01	187.
1.01	1.50	22	.01	.01	.01	6.	1.01	13.50	166	.26	.26	.01	187.
1.01	1.55	23	.01	.01	.01	6.	1.01	13.55	167	.26	.26	.01	187.
1.01	2.00	24	.01	.01	.01	6.	1.01	14.00	168	.26	.26	.01	188.
1.01	2.05	25	.01	.01	.01	6.	1.01	14.05	169	.33	.32	.01	201.
1.01	2.10	26	.01	.01	.01	6.	1.01	14.10	170	.33	.32	.01	221.
1.01	2.15	27	.01	.01	.01	6.	1.01	14.15	171	.33	.32	.01	230.
1.01	2.20	28	.01	.01	.01	6.	1.01	14.20	172	.33	.32	.01	234.
1.01	2.25	29	.01	.01	.01	6.	1.01	14.25	173	.33	.32	.01	235.
1.01	2.30	30	.01	.01	.01	6.	1.01	14.30	174	.33	.32	.01	236.
1.01	2.35	31	.01	.01	.01	6.	1.01	14.35	175	.33	.32	.01	236.
1.01	2.40	32	.01	.01	.01	6.	1.01	14.40	176	.33	.32	.01	236.
1.01	2.45	33	.01	.01	.01	6.	1.01	14.45	177	.33	.32	.01	237.
1.01	2.50	34	.01	.01	.01	6.	1.01	14.50	178	.33	.32	.01	237.
1.01	2.55	35	.01	.01	.01	6.	1.01	14.55	179	.33	.32	.01	237.
1.01	3.00	36	.01	.01	.01	6.	1.01	15.00	180	.33	.32	.01	237.
1.01	3.05	37	.01	.01	.01	6.	1.01	15.05	181	.20	.20	.00	211.
1.01	3.10	38	.01	.01	.01	6.	1.01	15.10	182	.40	.39	.01	213.
1.01	3.15	39	.01	.01	.01	6.	1.01	15.15	183	.40	.39	.01	256.
1.01	3.20	40	.01	.01	.01	6.	1.01	15.20	184	.60	.59	.01	317.
1.01	3.25	41	.01	.01	.01	6.	1.01	15.25	185	.70	.69	.01	406.
1.01	3.30	42	.01	.01	.01	6.	1.01	15.30	186	1.69	1.67	.02	671.
1.01	3.35	43	.01	.01	.01	6.	1.01	15.35	187	2.79	2.76	.02	1226.
1.01	3.40	44	.01	.01	.01	6.	1.01	15.40	188	1.10	1.09	.01	1356.
1.01	3.45	45	.01	.01	.01	6.	1.01	15.45	189	.70	.69	.00	980.
1.01	3.50	46	.01	.01	.01	6.	1.01	15.50	190	.60	.59	.00	670.
1.01	3.55	47	.01	.01	.01	6.	1.01	15.55	191	.40	.40	.00	487.
1.01	4.00	48	.01	.01	.01	6.	1.01	16.00	192	.40	.40	.00	370.
1.01	4.05	49	.01	.01	.01	6.	1.01	16.05	193	.31	.30	.00	302.
1.01	4.10	50	.01	.01	.01	6.	1.01	16.10	194	.31	.30	.00	254.
1.01	4.15	51	.01	.01	.01	6.	1.01	16.15	195	.31	.30	.00	234.
1.01	4.20	52	.01	.01	.01	6.	1.01	16.20	196	.31	.30	.00	227.
1.01	4.25	53	.01	.01	.01	6.	1.01	16.25	197	.31	.30	.00	225.
1.01	4.30	54	.01	.01	.01	6.	1.01	16.30	198	.31	.30	.00	224.
1.01	4.35	55	.01	.01	.01	6.	1.01	16.35	199	.31	.30	.00	224.

1.01	4.40	56	.01	.01	.01	6.	1.01	16.40	200	.31	.30	.00	224.
1.01	4.45	57	.01	.01	.01	6.	1.01	16.45	201	.31	.30	.00	224.
1.01	4.50	58	.01	.01	.01	6.	1.01	16.50	202	.31	.30	.00	224.
1.01	4.55	59	.01	.01	.01	6.	1.01	16.55	203	.31	.30	.00	224.
1.01	5.00	60	.01	.01	.01	6.	1.01	17.00	204	.31	.30	.00	224.
1.01	5.05	61	.01	.01	.01	6.	1.01	17.05	205	.24	.24	.00	210.
1.01	5.10	62	.01	.01	.01	6.	1.01	17.10	206	.24	.24	.00	190.
1.01	5.15	63	.01	.01	.01	6.	1.01	17.15	207	.24	.24	.00	181.
1.01	5.20	64	.01	.01	.01	6.	1.01	17.20	208	.24	.24	.00	178.
1.01	5.25	65	.01	.01	.01	6.	1.01	17.25	209	.24	.24	.00	177.
1.01	5.30	66	.01	.01	.01	7.	1.01	17.30	210	.24	.24	.00	176.
1.01	5.35	67	.01	.01	.01	7.	1.01	17.35	211	.24	.24	.00	176.
1.01	5.40	68	.01	.01	.01	7.	1.01	17.40	212	.24	.24	.00	176.
1.01	5.45	69	.01	.01	.01	7.	1.01	17.45	213	.24	.24	.00	176.
1.01	5.50	70	.01	.01	.01	7.	1.01	17.50	214	.24	.24	.00	176.
1.01	5.55	71	.01	.01	.01	7.	1.01	17.55	215	.24	.24	.00	176.
1.01	6.00	72	.01	.01	.01	7.	1.01	18.00	216	.24	.24	.00	176.
1.01	6.05	73	.06	.04	.02	13.	1.01	18.05	217	.02	.02	.00	154.
1.01	6.10	74	.06	.04	.02	24.	1.01	18.10	218	.02	.02	.00	123.
1.01	6.15	75	.06	.04	.02	28.	1.01	18.15	219	.02	.02	.00	112.
1.01	6.20	76	.06	.04	.02	31.	1.01	18.20	220	.02	.02	.00	102.
1.01	6.25	77	.06	.04	.02	32.	1.01	18.25	221	.02	.02	.00	93.
1.01	6.30	78	.06	.05	.02	32.	1.01	18.30	222	.02	.02	.00	85.
1.01	6.35	79	.06	.05	.02	33.	1.01	18.35	223	.02	.02	.00	77.
1.01	6.40	80	.06	.05	.02	33.	1.01	18.40	224	.02	.02	.00	71.
1.01	6.45	81	.06	.05	.02	34.	1.01	18.45	225	.02	.02	.00	65.
1.01	6.50	82	.06	.05	.02	34.	1.01	18.50	226	.02	.02	.00	59.
1.01	6.55	83	.06	.05	.02	35.	1.01	18.55	227	.02	.02	.00	54.
1.01	7.00	84	.06	.05	.02	35.	1.01	19.00	228	.02	.02	.00	49.
1.01	7.05	85	.06	.05	.02	35.	1.01	19.05	229	.02	.02	.00	45.
1.01	7.10	86	.06	.05	.02	36.	1.01	19.10	230	.02	.02	.00	41.
1.01	7.15	87	.06	.05	.01	36.	1.01	19.15	231	.02	.02	.00	37.
1.01	7.20	88	.06	.05	.01	36.	1.01	19.20	232	.02	.02	.00	34.
1.01	7.25	89	.06	.05	.01	37.	1.01	19.25	233	.02	.02	.00	31.
1.01	7.30	90	.06	.05	.01	37.	1.01	19.30	234	.02	.02	.00	28.
1.01	7.35	91	.06	.05	.01	37.	1.01	19.35	235	.02	.02	.00	26.
1.01	7.40	92	.06	.05	.01	38.	1.01	19.40	236	.02	.02	.00	24.
1.01	7.45	93	.06	.05	.01	38.	1.01	19.45	237	.02	.02	.00	21.
1.01	7.50	94	.06	.05	.01	38.	1.01	19.50	238	.02	.02	.00	20.
1.01	7.55	95	.06	.05	.01	38.	1.01	19.55	239	.02	.02	.00	18.
1.01	8.00	96	.06	.05	.01	38.	1.01	20.00	240	.02	.02	.00	16.
1.01	8.05	97	.06	.05	.01	39.	1.01	20.05	241	.02	.02	.00	16.
1.01	8.10	98	.06	.05	.01	39.	1.01	20.10	242	.02	.02	.00	16.
1.01	8.15	99	.06	.05	.01	39.	1.01	20.15	243	.02	.02	.00	16.
1.01	8.20	100	.06	.05	.01	39.	1.01	20.20	244	.02	.02	.00	16.
1.01	8.25	101	.06	.05	.01	39.	1.01	20.25	245	.02	.02	.00	16.
1.01	8.30	102	.06	.05	.01	40.	1.01	20.30	246	.02	.02	.00	16.
1.01	8.35	103	.06	.05	.01	40.	1.01	20.35	247	.02	.02	.00	16.
1.01	8.40	104	.06	.05	.01	40.	1.01	20.40	248	.02	.02	.00	16.
1.01	8.45	105	.06	.05	.01	40.	1.01	20.45	249	.02	.02	.00	16.
1.01	8.50	106	.06	.05	.01	40.	1.01	20.50	250	.02	.02	.00	16.
1.01	8.55	107	.06	.05	.01	40.	1.01	20.55	251	.02	.02	.00	16.
1.01	9.00	108	.06	.05	.01	41.	1.01	21.00	252	.02	.02	.00	16.
1.01	9.05	109	.06	.05	.01	41.	1.01	21.05	253	.02	.02	.00	16.
1.01	9.10	110	.06	.05	.01	41.	1.01	21.10	254	.02	.02	.00	16.
1.01	9.15	111	.06	.05	.01	41.	1.01	21.15	255	.02	.02	.00	16.
1.01	9.20	112	.06	.05	.01	41.	1.01	21.20	256	.02	.02	.00	16.
1.01	9.25	113	.06	.05	.01	41.	1.01	21.25	257	.02	.02	.00	16.
1.01	9.30	114	.06	.05	.01	41.	1.01	21.30	258	.02	.02	.00	16.
1.01	9.35	115	.06	.05	.01	42.	1.01	21.35	259	.02	.02	.00	16.

1.01	9.40	116	.06	.06	.01	42.	1.01	21.40	260	.02	.02	.00	16.
1.01	9.45	117	.06	.06	.01	42.	1.01	21.45	261	.02	.02	.00	16.
1.01	9.50	118	.06	.06	.01	42.	1.01	21.50	262	.02	.02	.00	16.
1.01	9.55	119	.06	.06	.01	42.	1.01	21.55	263	.02	.02	.00	16.
1.01	10.00	120	.06	.06	.01	42.	1.01	22.00	264	.02	.02	.00	16.
1.01	10.05	121	.06	.06	.01	42.	1.01	22.05	265	.02	.02	.00	16.
1.01	10.10	122	.06	.06	.01	42.	1.01	22.10	266	.02	.02	.00	16.
1.01	10.15	123	.06	.06	.01	42.	1.01	22.15	267	.02	.02	.00	16.
1.01	10.20	124	.06	.06	.01	42.	1.01	22.20	268	.02	.02	.00	16.
1.01	10.25	125	.06	.06	.01	43.	1.01	22.25	269	.02	.02	.00	16.
1.01	10.30	126	.06	.06	.01	43.	1.01	22.30	270	.02	.02	.00	16.
1.01	10.35	127	.06	.06	.01	43.	1.01	22.35	271	.02	.02	.00	16.
1.01	10.40	128	.06	.06	.01	43.	1.01	22.40	272	.02	.02	.00	16.
1.01	10.45	129	.06	.06	.01	43.	1.01	22.45	273	.02	.02	.00	16.
1.01	10.50	130	.06	.06	.01	43.	1.01	22.50	274	.02	.02	.00	16.
1.01	10.55	131	.06	.06	.01	43.	1.01	22.55	275	.02	.02	.00	16.
1.01	11.00	132	.06	.06	.01	43.	1.01	23.00	276	.02	.02	.00	16.
1.01	11.05	133	.06	.06	.01	43.	1.01	23.05	277	.02	.02	.00	16.
1.01	11.10	134	.06	.06	.01	43.	1.01	23.10	278	.02	.02	.00	16.
1.01	11.15	135	.06	.06	.01	43.	1.01	23.15	279	.02	.02	.00	16.
1.01	11.20	136	.06	.06	.01	43.	1.01	23.20	280	.02	.02	.00	16.
1.01	11.25	137	.06	.06	.01	43.	1.01	23.25	281	.02	.02	.00	16.
1.01	11.30	138	.06	.06	.01	43.	1.01	23.30	282	.02	.02	.00	16.
1.01	11.35	139	.06	.06	.00	44.	1.01	23.35	283	.02	.02	.00	16.
1.01	11.40	140	.06	.06	.00	44.	1.01	23.40	284	.02	.02	.00	16.
1.01	11.45	141	.06	.06	.00	44.	1.01	23.45	285	.02	.02	.00	16.
1.01	11.50	142	.06	.06	.00	44.	1.01	23.50	286	.02	.02	.00	16.
1.01	11.55	143	.06	.06	.00	44.	1.01	23.55	287	.02	.02	.00	16.
1.01	12.00	144	.06	.06	.00	44.	1.02	0.00	288	.02	.02	.00	16.
									SUM	33.41	31.79	1.62	24174.
										(849.)(	807.)(	41.)(	684.53)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1356.	202.	84.	84.	24149.
CMS	38.	7.	2.	2.	684.
INCHES		25.64	32.84	32.84	32.84
MM		651.21	834.20	834.20	834.20
AC-FT		130.	166.	166.	166.
THOUS CU M		160.	205.	205.	205.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTING THROUGH RESERVOIR OF DAM ID # 30711

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
POND	1	0	0	1	1	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-733.	-1

STAGE	725.00	732.90	734.10	734.50	734.70	735.00	736.00	737.00	738.00
FLOW	0.00	.00	48.00	90.00	125.00	230.00	360.00	750.00	1500.00
SURFACE AREA=	0.	2.	12.	22.	34.				
CAPACITY=	0.	2.	31.	81.	192.				
ELEVATION=	725.	728.	733.	736.	740.				

CREL	SPWID	COQW	EXPW	FLEVL	COQL	CAREA	EXPL
732.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
736.0	0.0	0.0	0.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

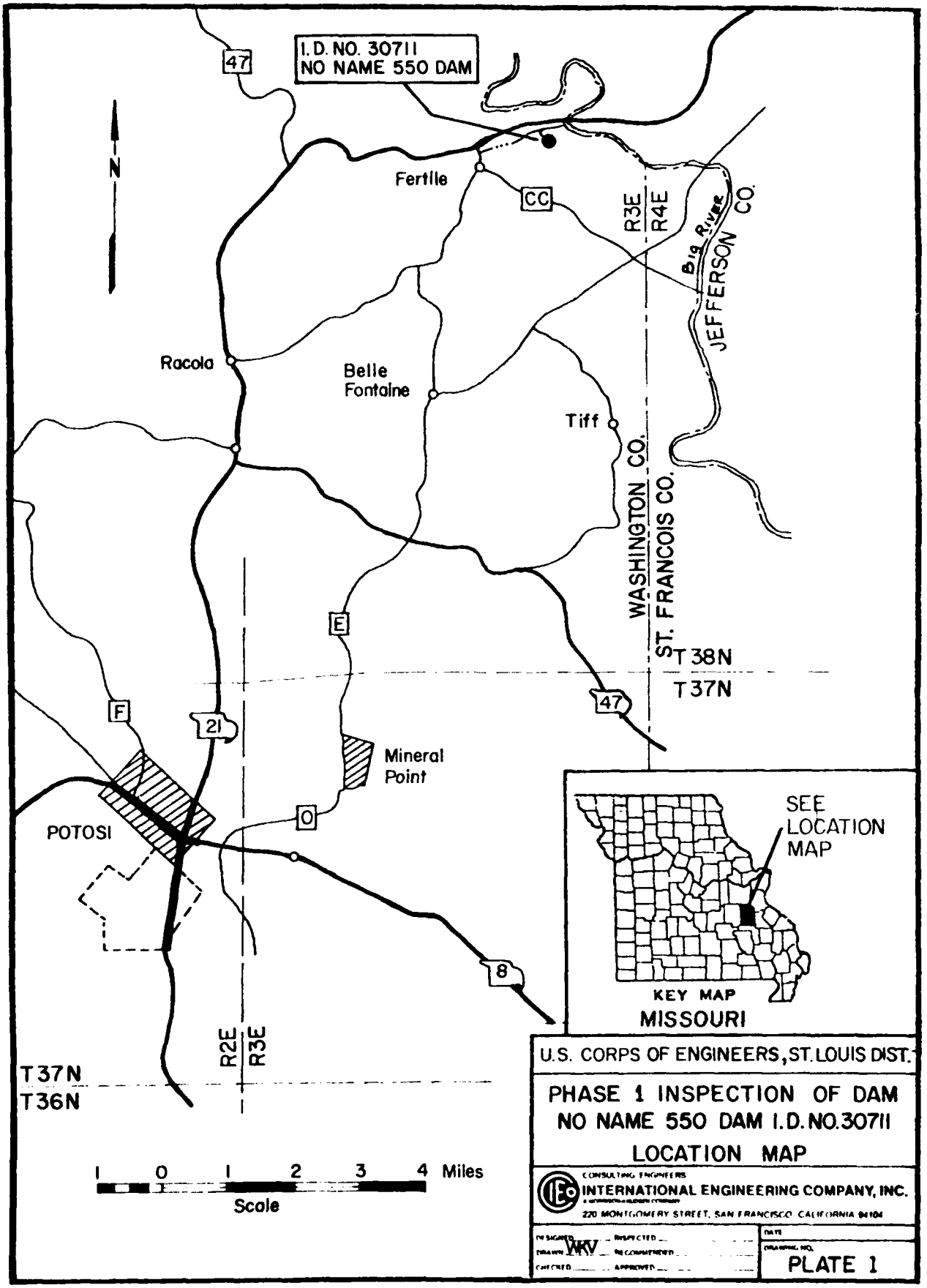
OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .50	RATIO 2 .50	RATIO 3 .60	RATIO 4 .80	RATIO 5 .90	RATIO 6 1.00
HYDROGRAPH AT	INFLOW	.10	1	407.	678.	813.	1085.	1220.	1356.
	(	.25)	(	11.52)(	19.20)(	23.03)(	30.71)(	34.55)(	38.39)(
ROUTED TO	POND	.10	1	84.	238.	273.	333.	360.	426.
	(	.25)	(	2.34)(	6.73)(	7.73)(	9.44)(	10.19)(	12.07)(

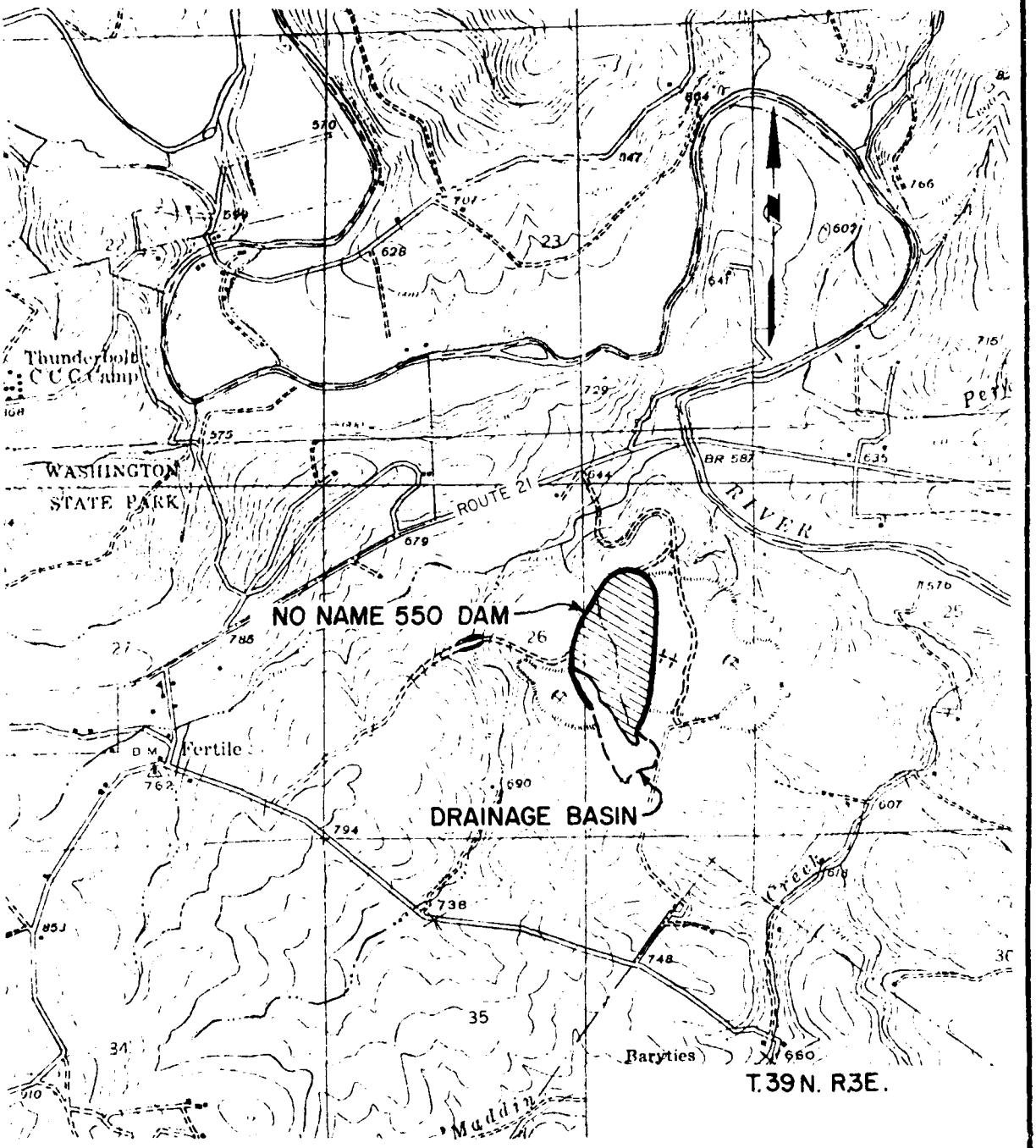
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	732.90	732.90	736.00
STORAGE	30.	30.	81.
OUTFLOW	0.	0.	360.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	734.45	0.00	52.	84.	0.00	16.08	0.00
.50	735.06	0.00	62.	238.	0.00	15.92	0.00
.60	735.33	0.00	67.	273.	0.00	15.92	0.00
.80	735.79	0.00	77.	333.	0.00	16.00	0.00
.90	736.00	0.00	81.	360.	0.00	16.00	0.00
1.00	736.17	.17	85.	426.	.58	16.00	0.00


I.D. NO. 30711
NO NAME 550 DAM
47
N
Fertile
CC
R3E
R4E
Big River
JEFFERSON CO.
Racola
Belle Fontaine
Tiff
WASHINGTON CO.
ST. FRANCOIS CO.
E
T38N
T37N
47
F
21
Mineral Point
O
POTOSI
8
R2E
R3E
T37N
T36N
1 0 1 2 3 4 Miles
Scale
SEE LOCATION MAP
KEY MAP
MISSOURI
U.S. CORPS OF ENGINEERS, ST. LOUIS DIST.
PHASE 1 INSPECTION OF DAM
NO NAME 550 DAM I.D. NO. 30711
LOCATION MAP
CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
220 MONTGOMERY STREET, SAN FRANCISCO, CALIFORNIA 94104
DESIGNED
DRAWN WKV
CHECKED
INSPECTED
RECOMMENDED
APPROVED
DATE
DRAWING NO.
PLATE 1

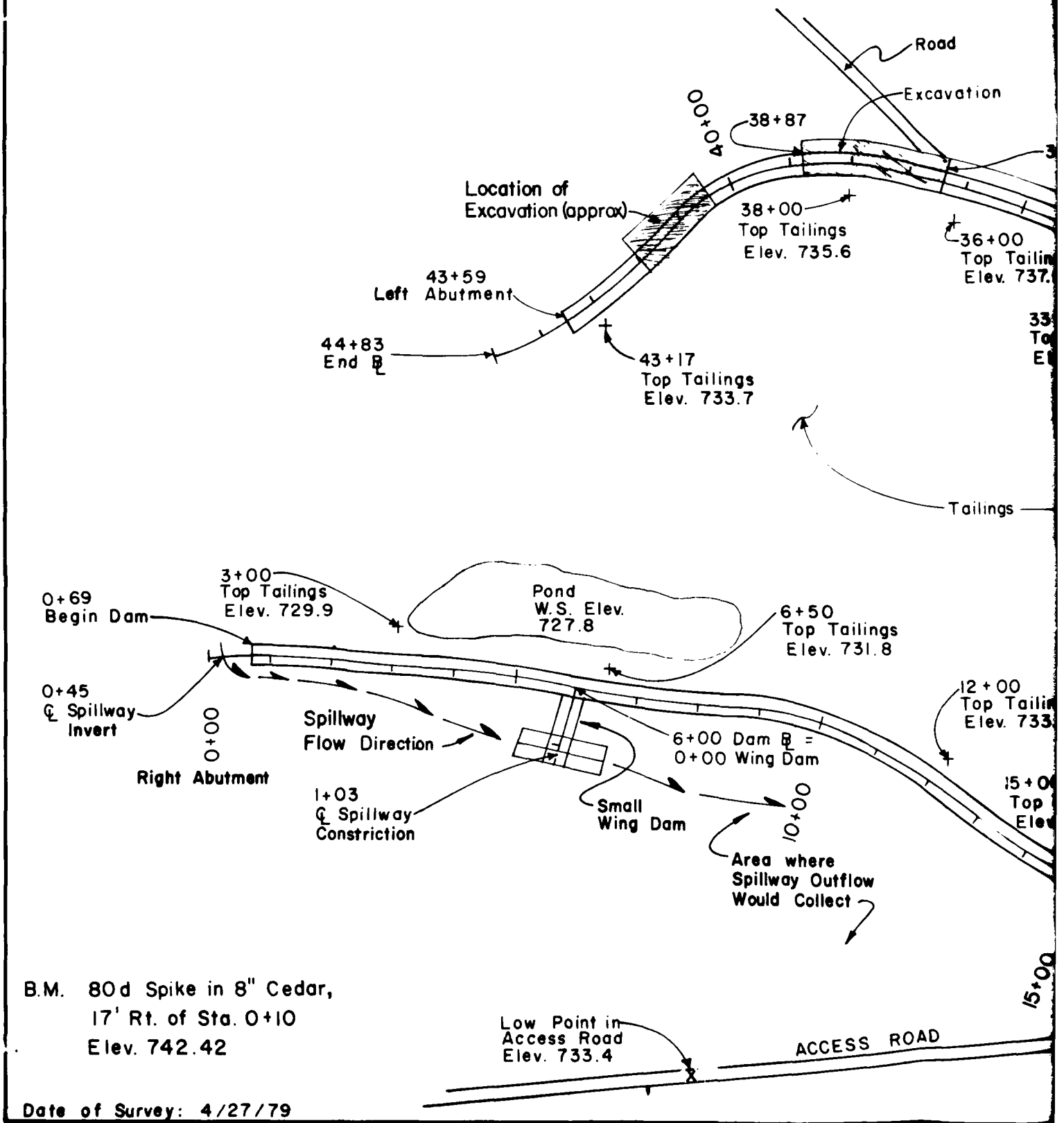


U.S. CORPS OF ENGINEERS, ST. LOUIS DIST.

PHASE I INSPECTION OF DAMS
NO NAME 550 DAM I.D. NO. 30711
VICINITY TOPOGRAPHY

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
220 MONTGOMERY STREET SAN FRANCISCO CALIFORNIA 94104

DESIGNED ____ INSPECTED ____ DATE
DRAWN ____ RECOMMENDED ____ DRAWING NO.
CHECKED ____ APPROVED ____ PLATE 2


Road
Excavation
00+04
38+87
Location of
Excavation (approx)
38+00
Top Tailings
Elev. 735.6
36+00
Top Tailin
Elev. 737.
43+59
Left Abutment
44+83
End ℄
43+17
Top Tailings
Elev. 733.7
Tailings
3+00
Top Tailings
Elev. 729.9
Pond
W.S. Elev.
727.8
6+50
Top Tailings
Elev. 731.8
0+69
Begin Dam
0+45
℄ Spillway
Invert
00+0
Right Abutment
Spillway
Flow Direction
6+00 Dam ℄ =
0+00 Wing Dam
12+00
Top Tailin
Elev. 733
1+03
℄ Spillway
Constriction
Small
Wing Dam
10+00
Area where
Spillway Outflow
Would Collect
B.M. 80d Spike in 8" Cedar,
17' Rt. of Sta. 0+10
Elev. 742.42
Low Point in
Access Road
Elev. 733.4
ACCESS ROAD
15+00
Date of Survey: 4/27/79

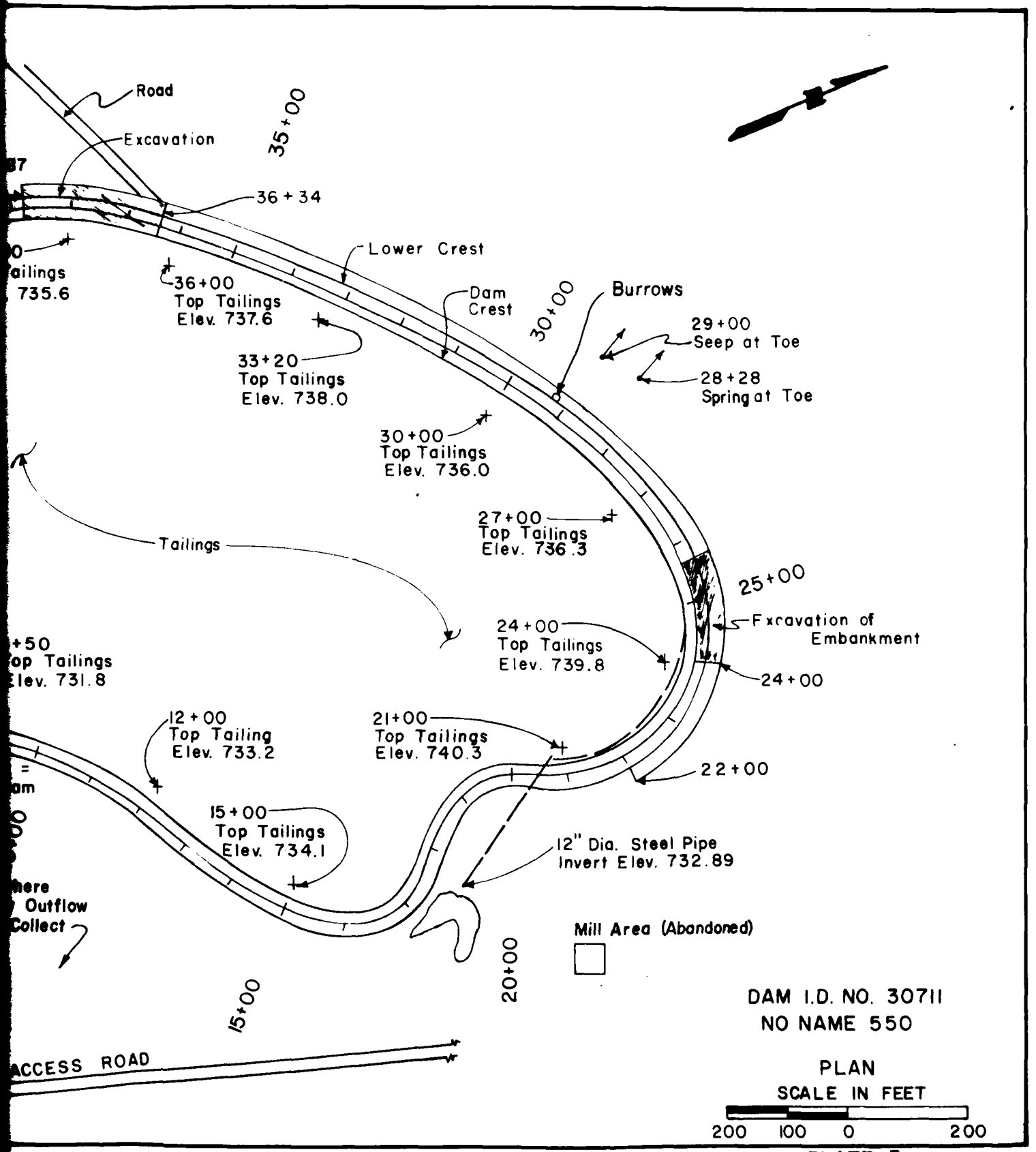
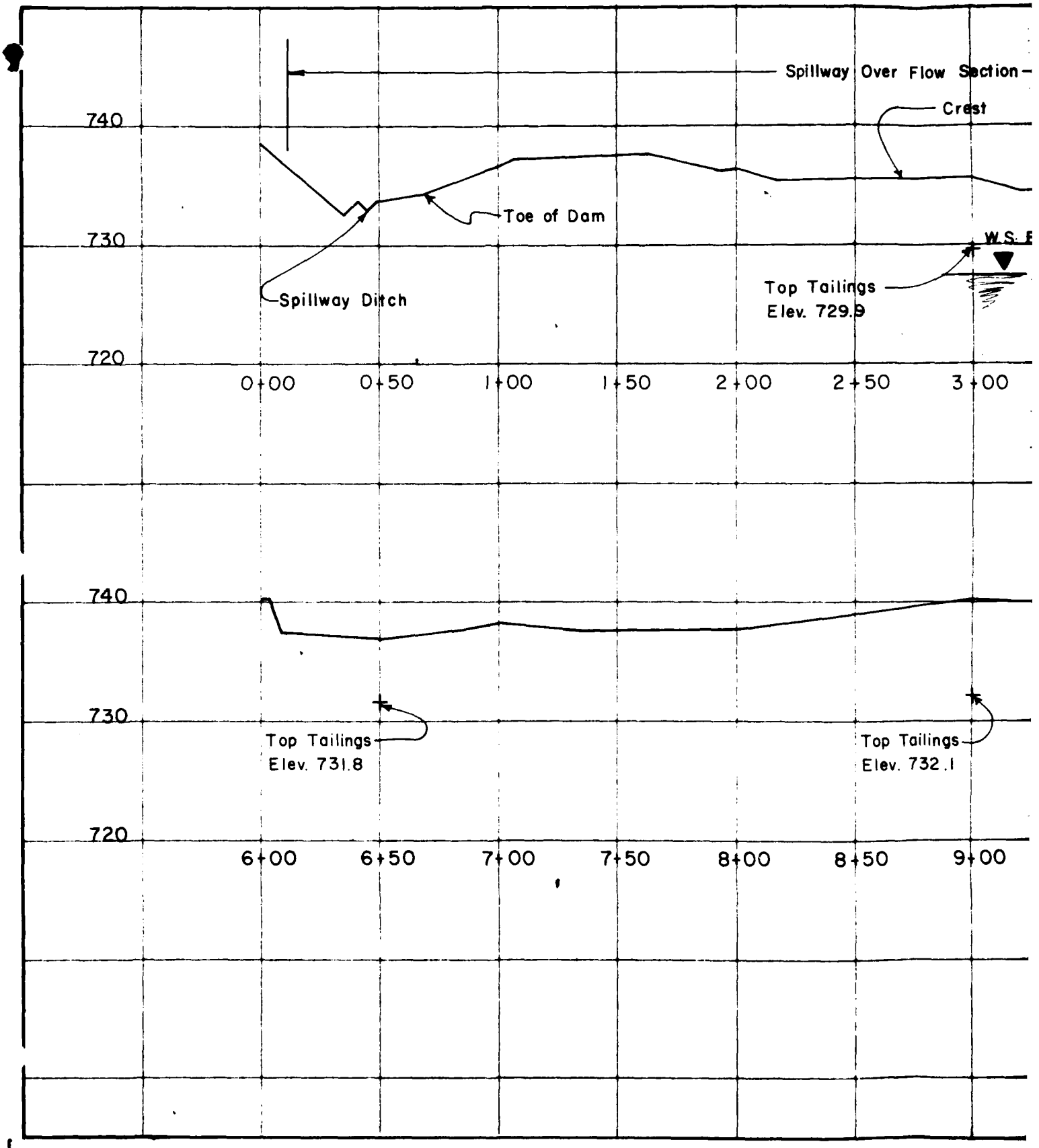
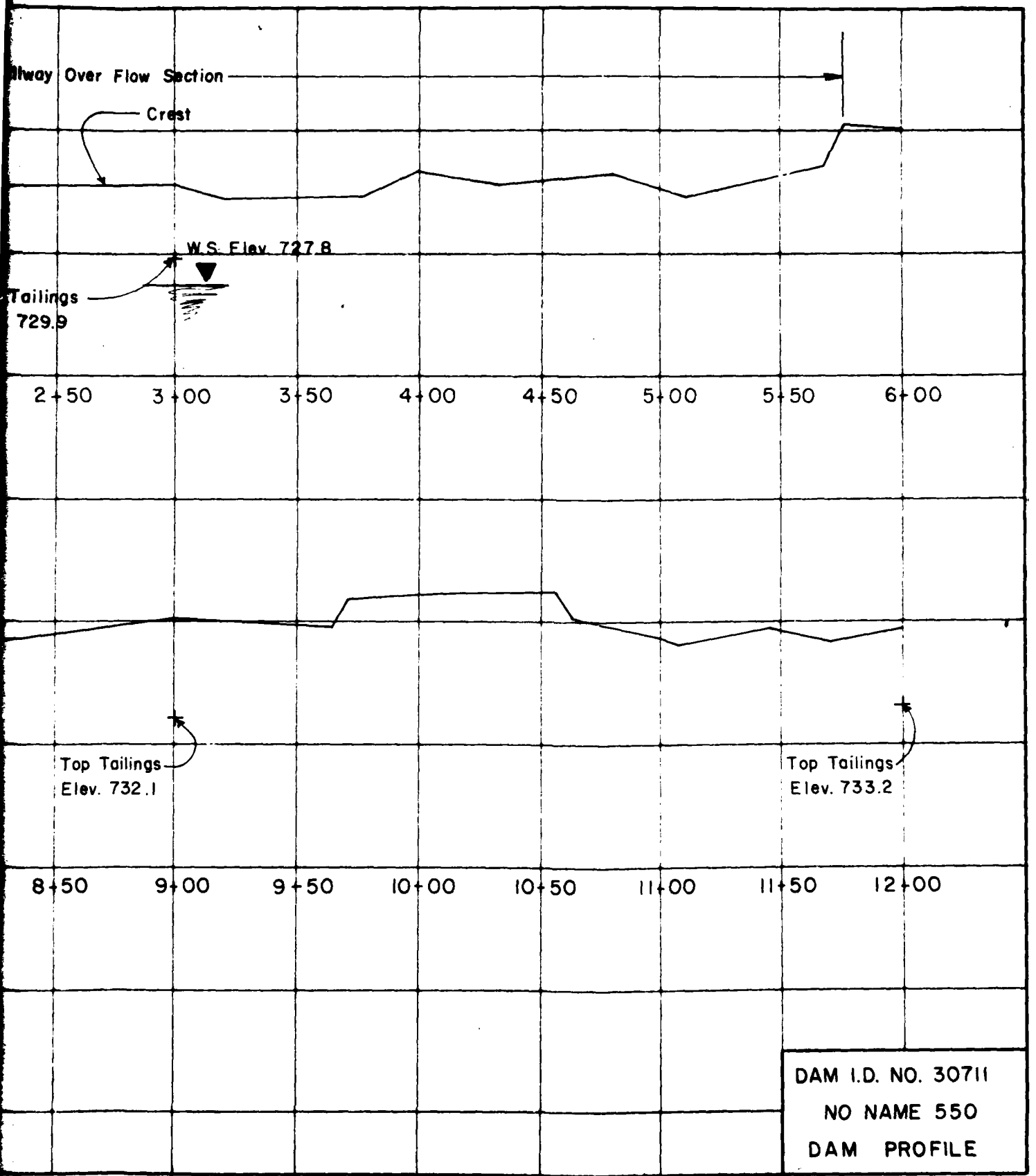

Road
Excavation
35+00
36+34
Lower Crest
36+00
Top Tailings
Elev. 737.6
Dam
Crest
30+00
Burrows
29+00
Seep at Toe
28+28
Spring at Toe
33+20
Top Tailings
Elev. 738.0
30+00
Top Tailings
Elev. 736.0
27+00
Top Tailings
Elev. 736.3
Tailings
25+00
Excavation of
Embankment
24+00
Top Tailings
Elev. 739.8
24+00
12+00
Top Tailing
Elev. 733.2
21+00
Top Tailings
Elev. 740.3
22+00
15+00
Top Tailings
Elev. 734.1
12" Dia. Steel Pipe
Invert Elev. 732.89
Mill Area (Abandoned)
20+00
15+00
ACCESS ROAD
DAM I.D. NO. 30711
NO NAME 550
PLAN
SCALE IN FEET
200 100 0 200

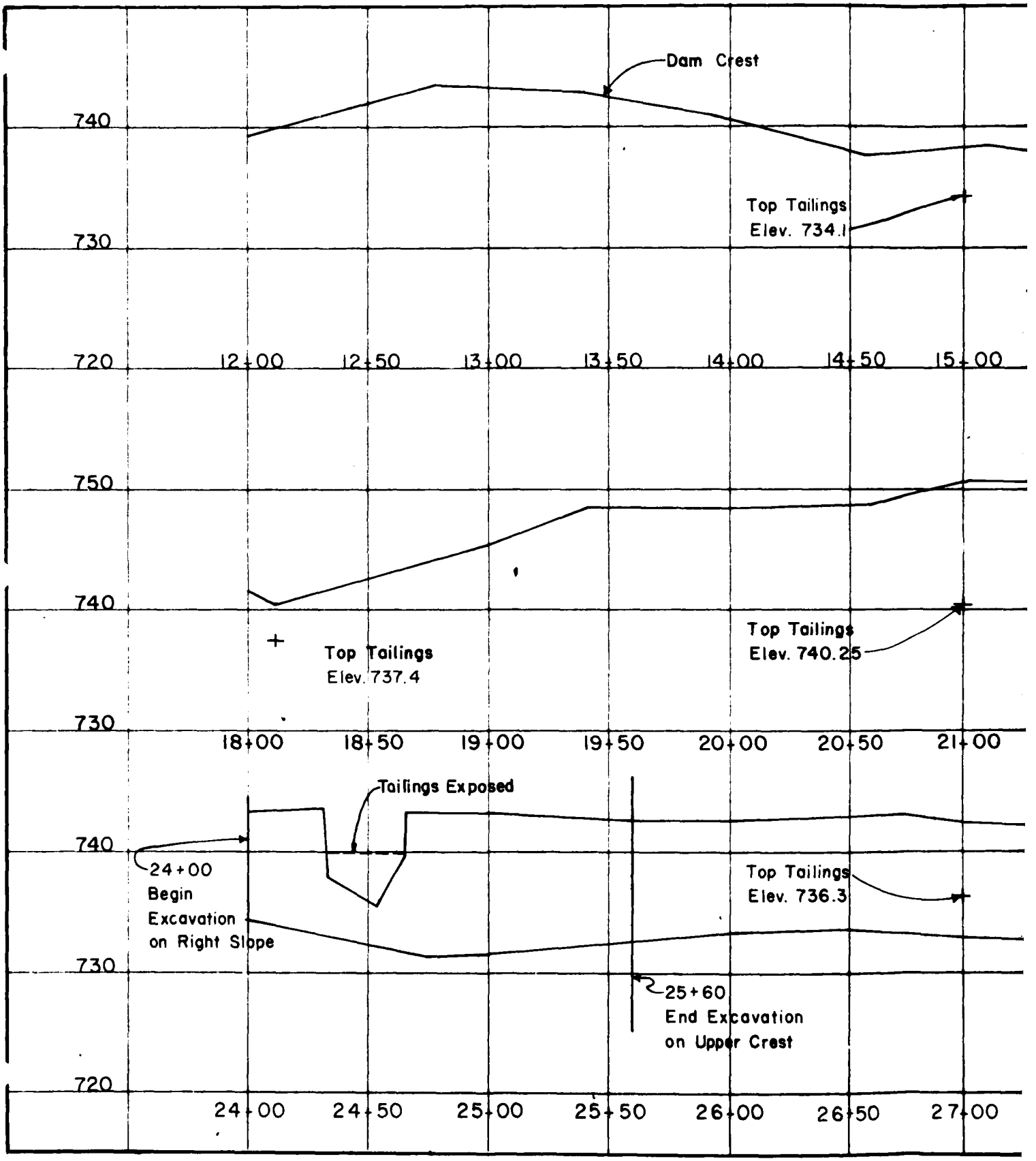
PLATE 3

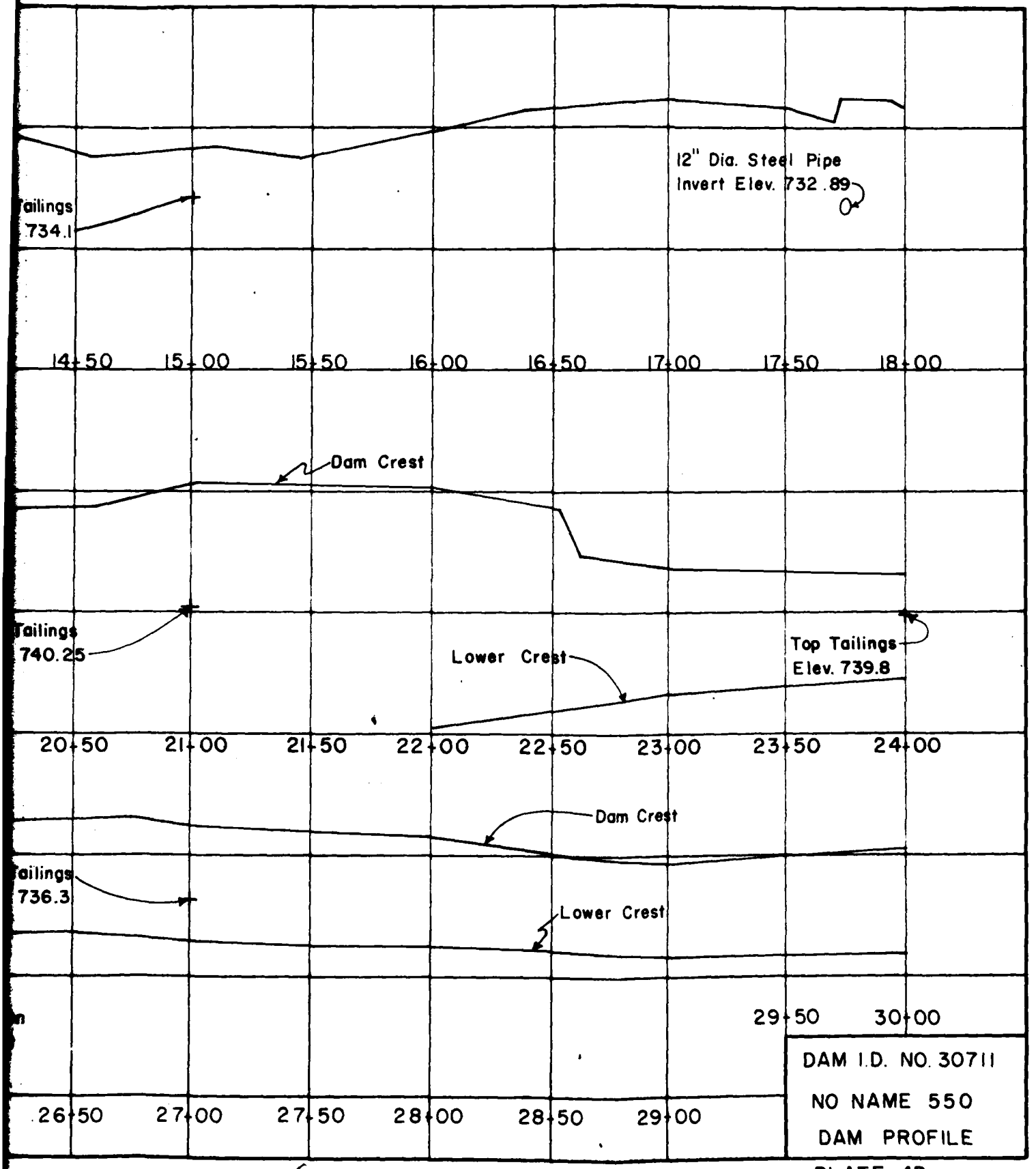

Spillway Over Flow Section
Crest
740
730
720
Toe of Dam
W.S. E
Spillway Ditch
Top Tailings
Elev. 729.9
0+00
0+50
1+00
1+50
2+00
2+50
3+00
740
730
720
Top Tailings
Elev. 731.8
Top Tailings
Elev. 732.1
6+00
6+50
7+00
7+50
8+00
8+50
9+00



DAM I.D. NO. 30711
NO NAME 550
DAM PROFILE
PLATE 4A

12


Dam Crest
740
730
720
12+00
12+50
13+00
13+50
14+00
14+50
15+00
Top Tailings
Elev. 734.1
750
740
730
18+00
18+50
19+00
19+50
20+00
20+50
21+00
Top Tailings
Elev. 737.4
Top Tailings
Elev. 740.25
Tailings Exposed
740
730
720
24+00
24+50
25+00
25+50
26+00
26+50
27+00
24+00
Begin
Excavation
on Right Slope
Top Tailings
Elev. 736.3
25+60
End Excavation
on Upper Crest

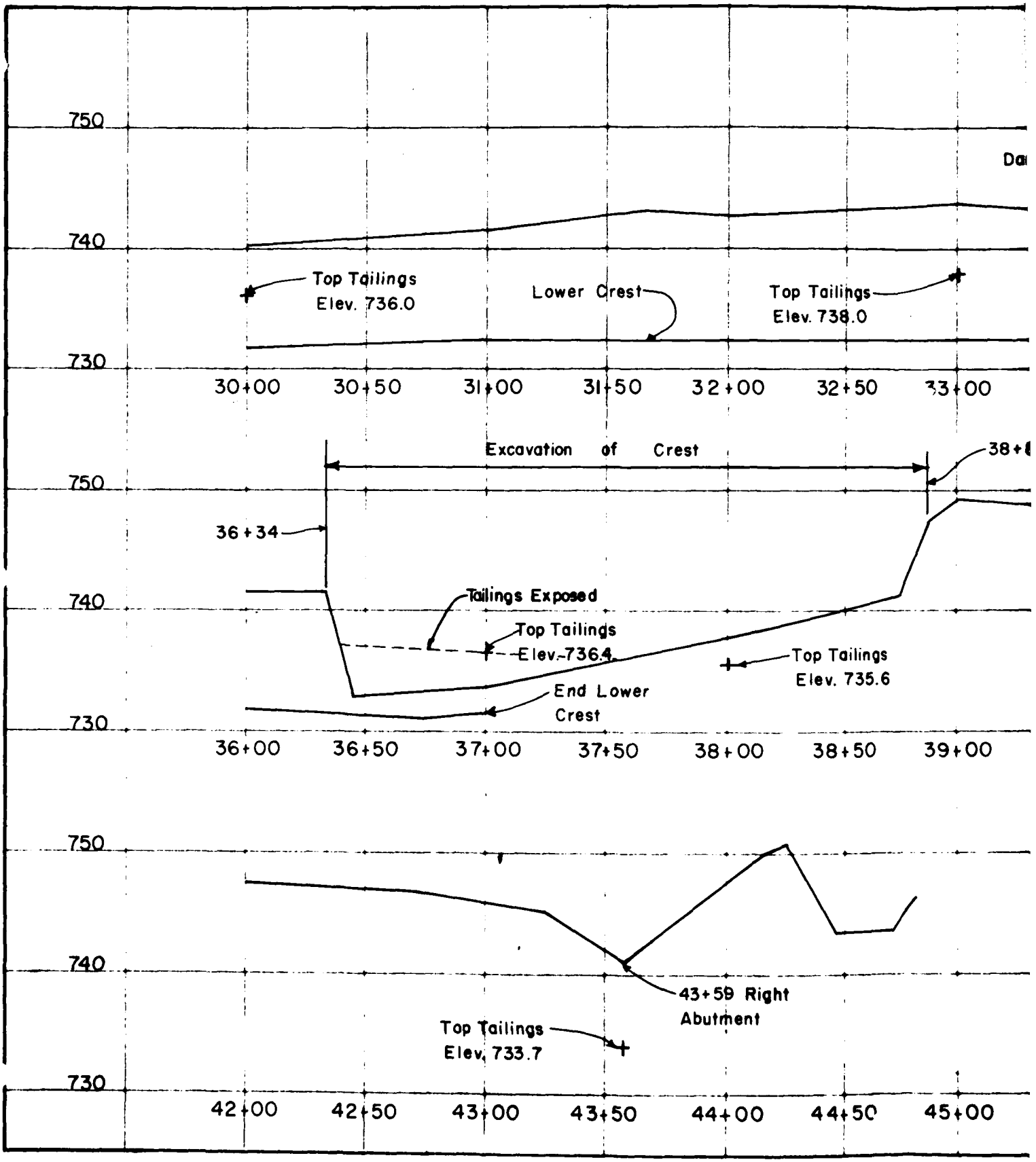


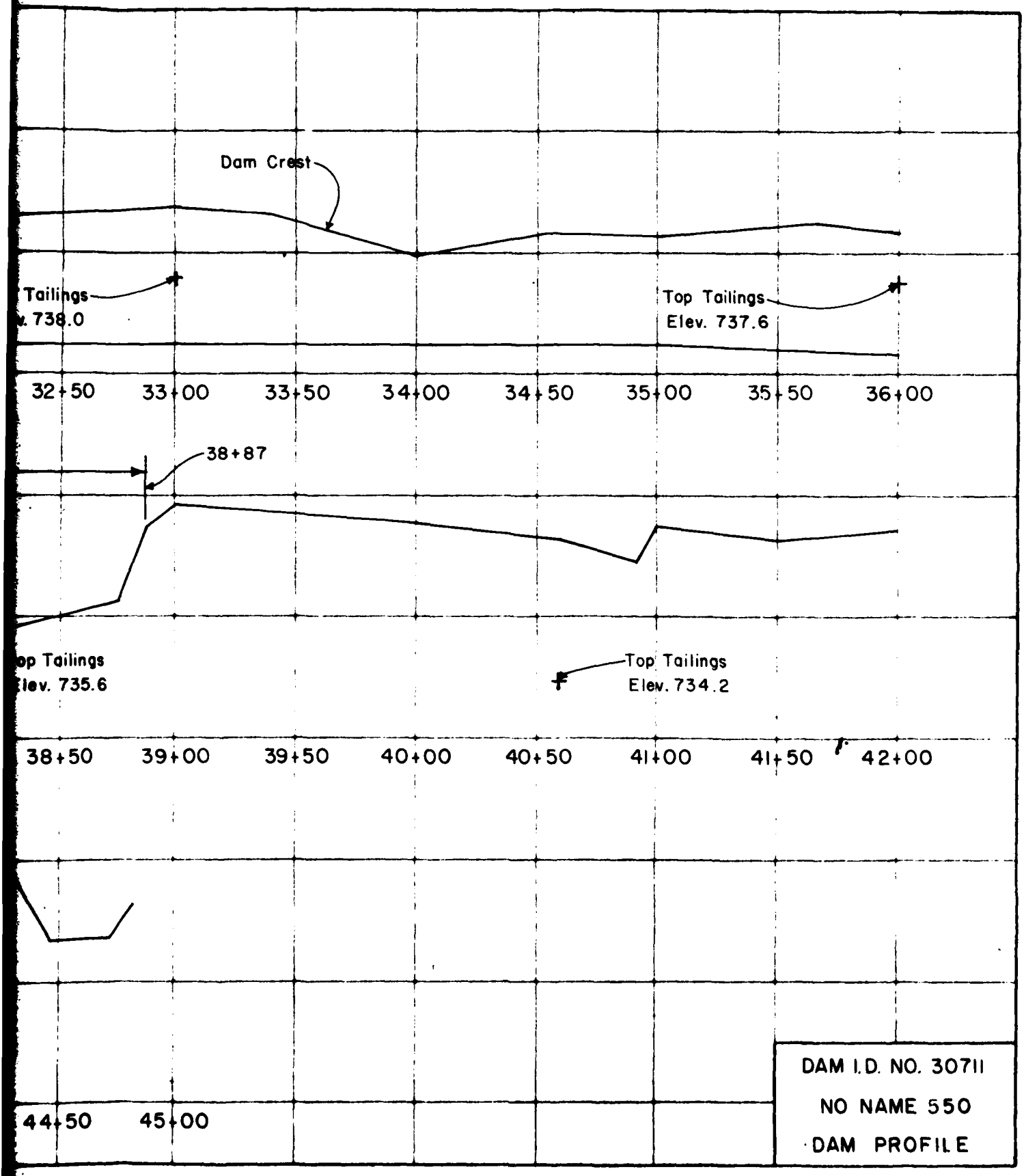
DAM I.D. NO. 30711

NO NAME 550

DAM PROFILE

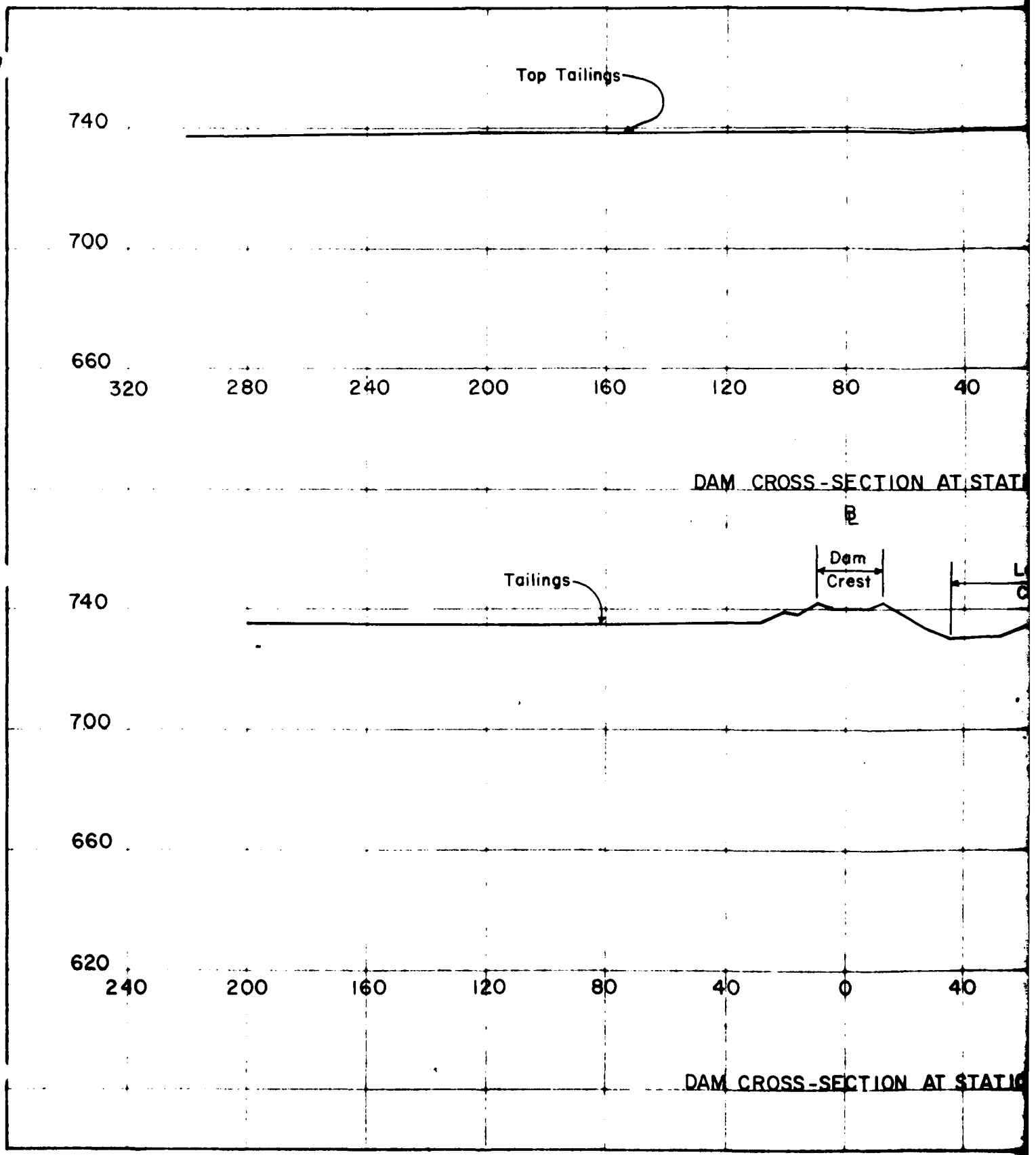
PLATE 4B


750
740
730
Top Tailings
Elev. 736.0
Lower Crest
Top Tailings
Elev. 738.0
30+00
30+50
31+00
31+50
32+00
32+50
33+00
Excavation of Crest
36+34
Tailings Exposed
Top Tailings
Elev. 736.4
Top Tailings
Elev. 735.6
End Lower
Crest
36+00
36+50
37+00
37+50
38+00
38+50
39+00
43+59 Right
Abutment
Top Tailings
Elev. 733.7
42+00
42+50
43+00
43+50
44+00
44+50
45+00



DAM I.D. NO. 30711
NO NAME 550
DAM PROFILE

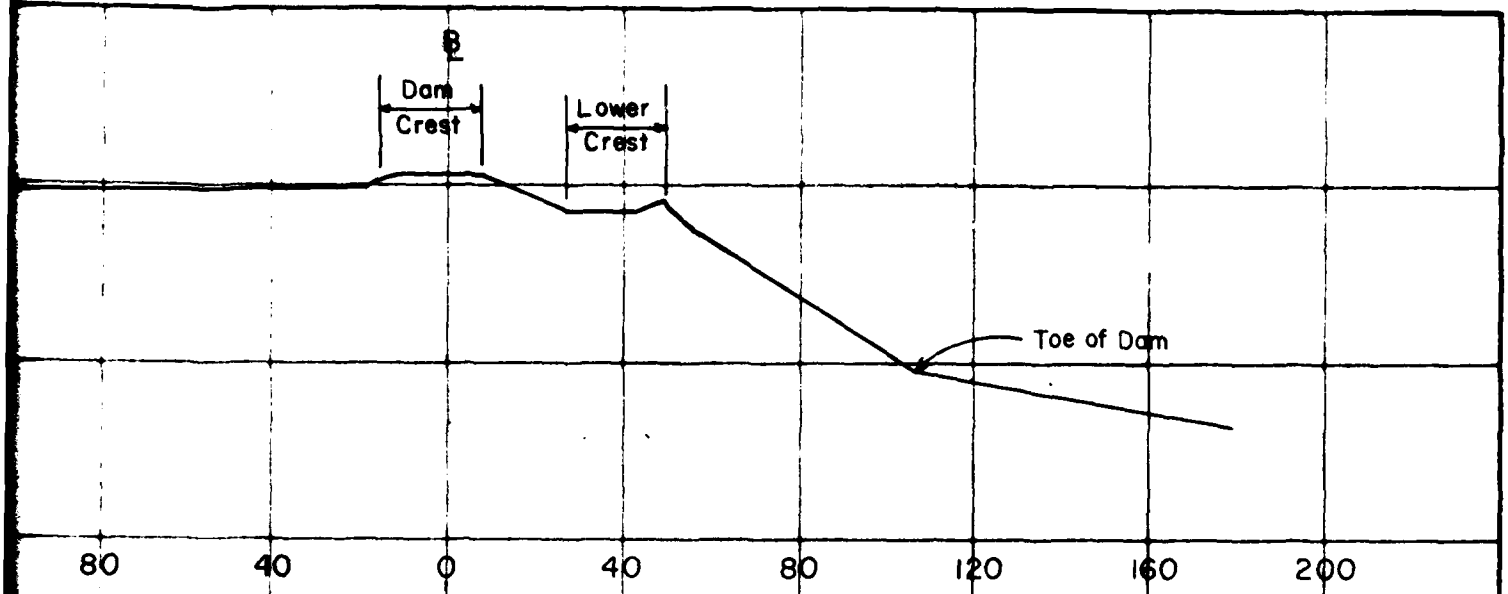
PLATE 4C



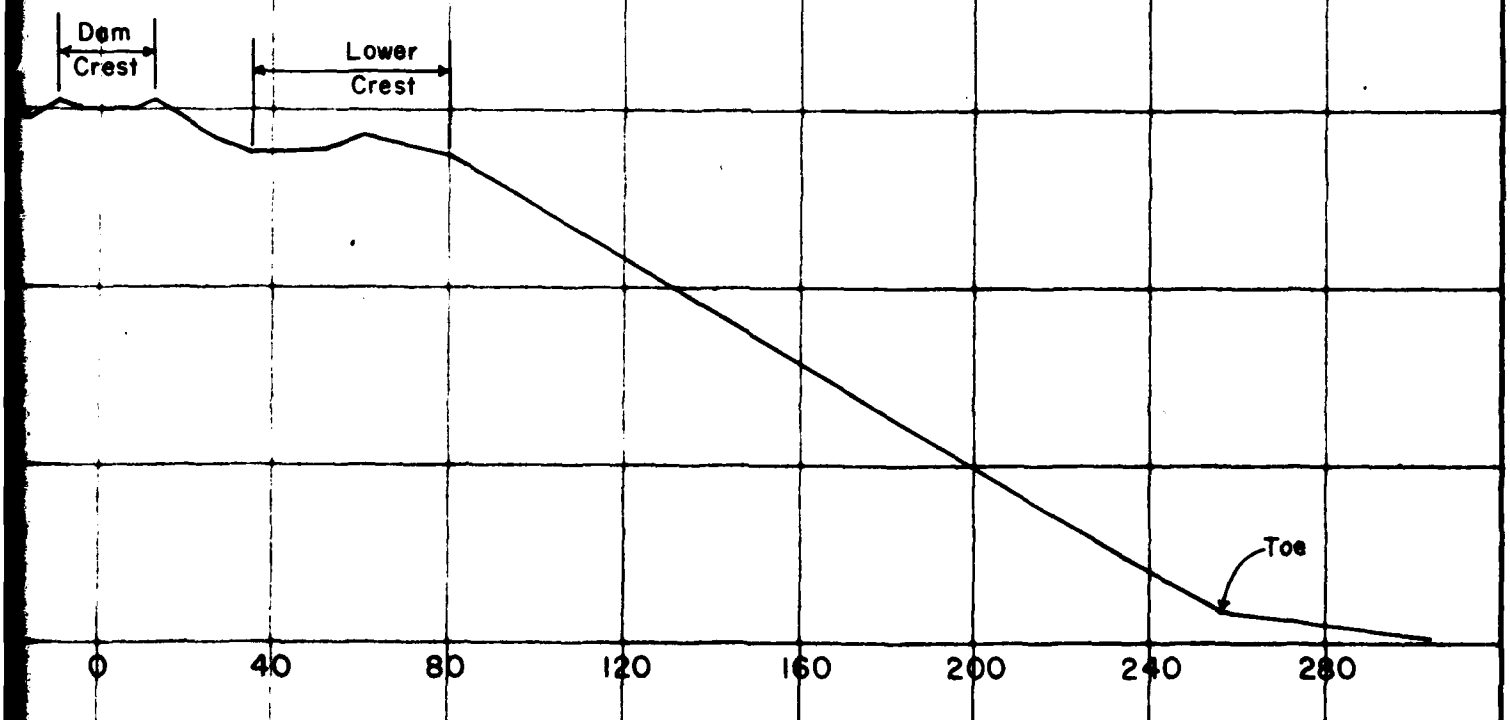
DAM CROSS-SECTION AT STATI

℄

DAM CROSS-SECTION AT STATIO



SS-SECTION AT STATION 24+00 ℄ DAM

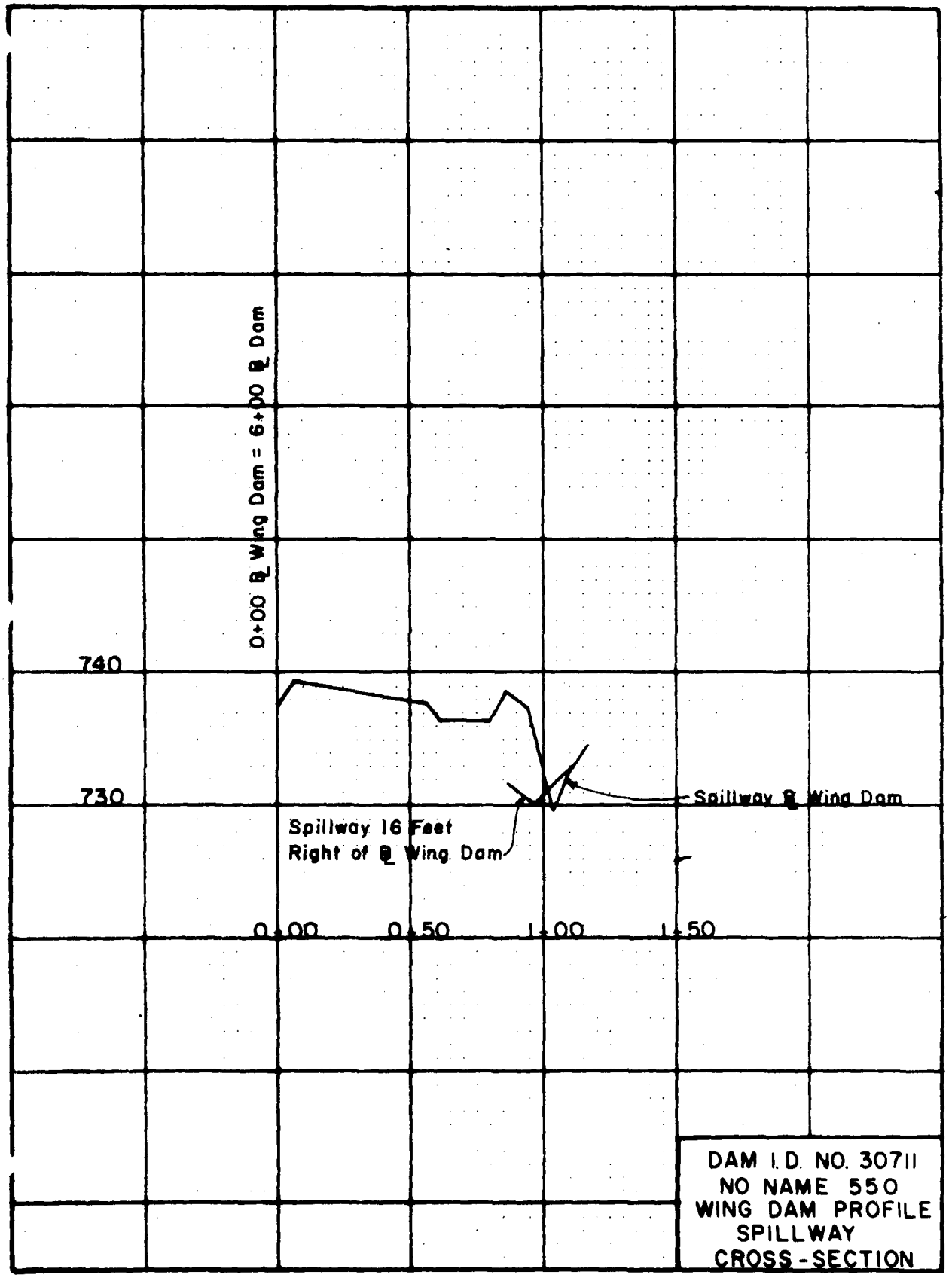


-SECTION AT STATION 28+60 ℄ DAM

DAM I.D. NO. 30711
NO NAME 550
DAM CROSS-SECTIONS

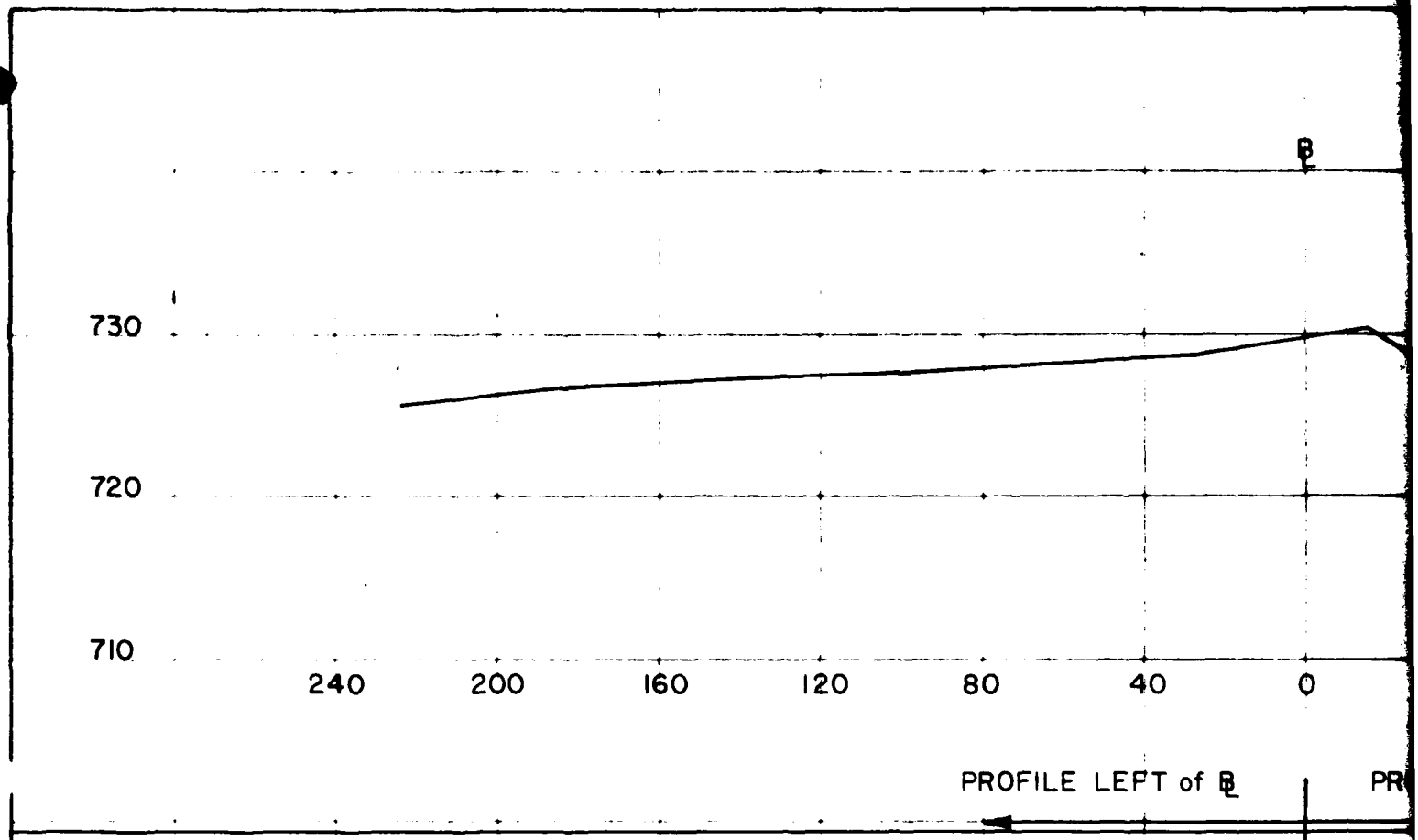
PLATE 5

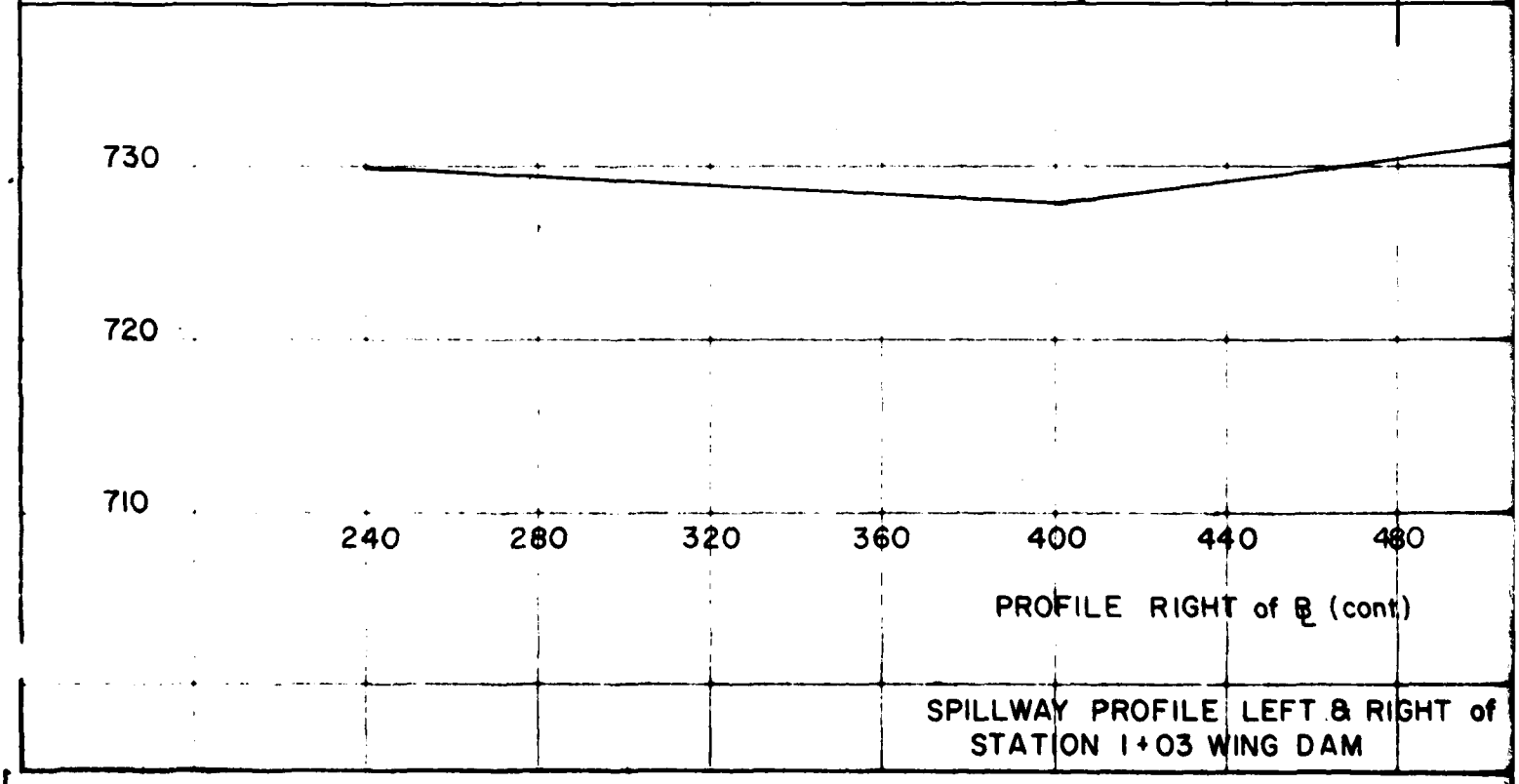
1 2



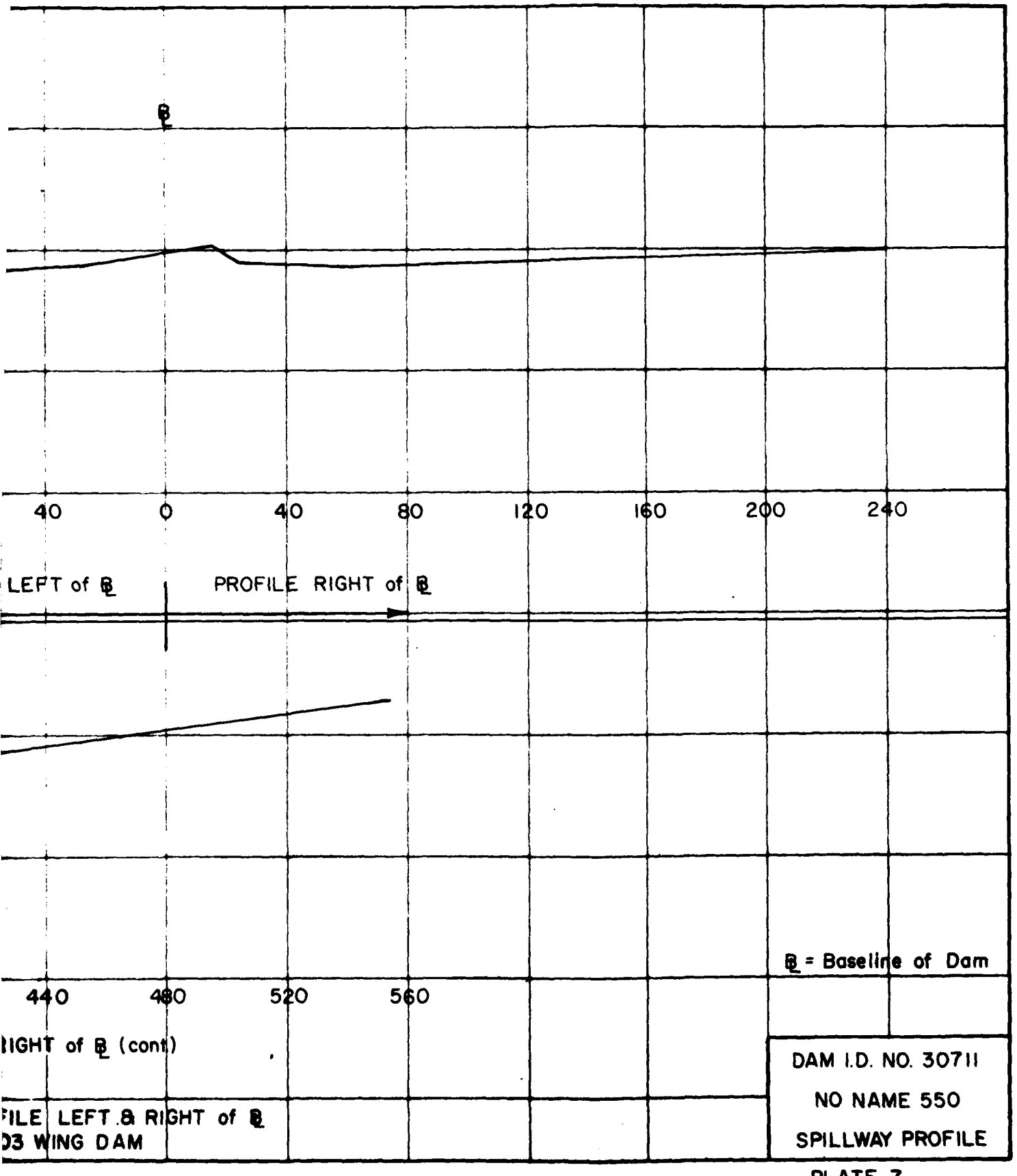
DAM I.D. NO. 30711
NO NAME 550
WING DAM PROFILE
SPILLWAY
CROSS-SECTION

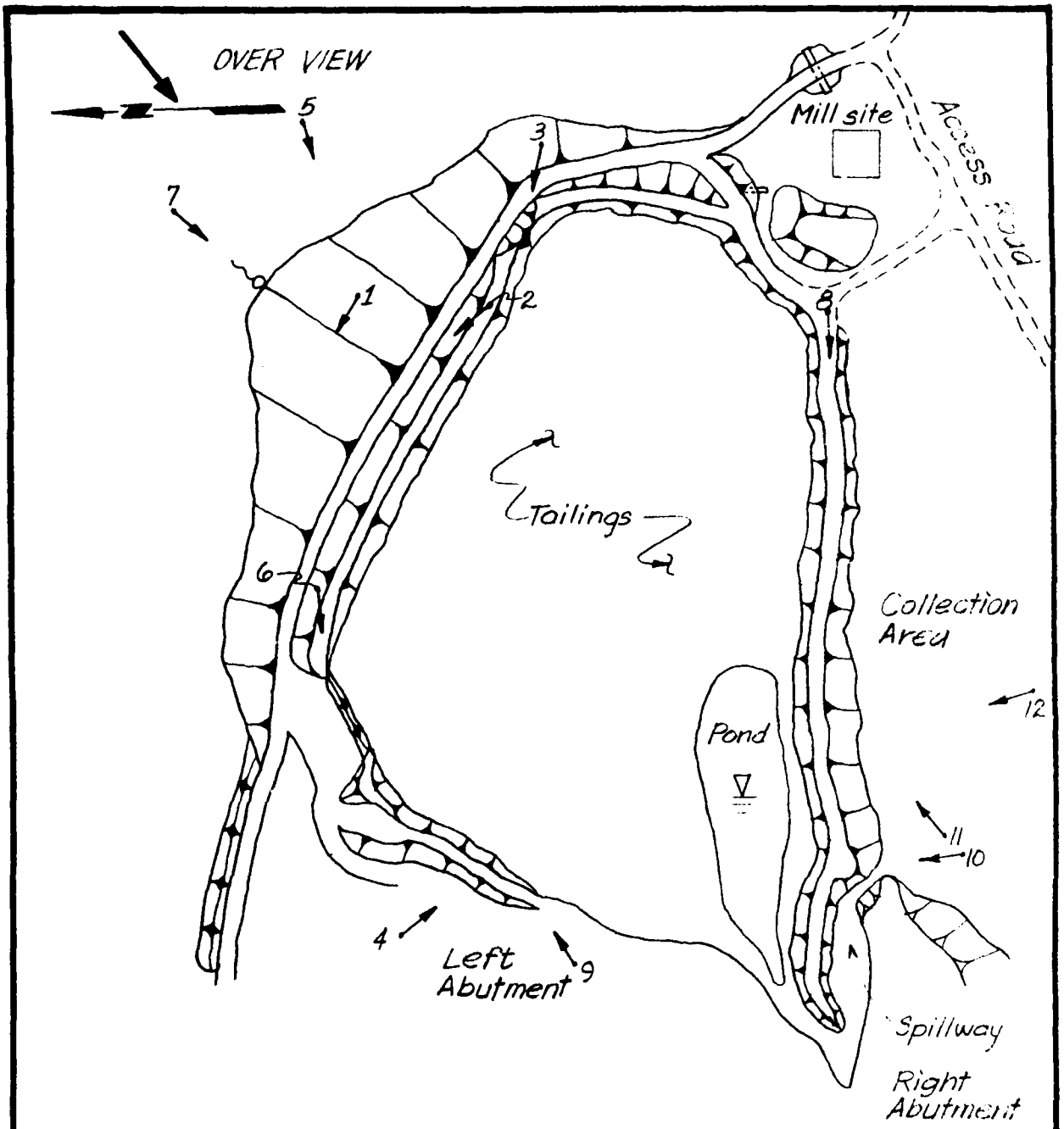
PLATE 6





SPILLWAY PROFILE LEFT & RIGHT of STATION 1+03 WING DAM


℄
40
0
40
80
120
160
200
240
LEFT of ℄
PROFILE RIGHT of ℄
℄ = Baseline of Dam
440
480
520
560
IIGHT of ℄ (cont)
FILE LEFT & RIGHT of ℄
03 WING DAM
DAM I.D. NO. 30711
NO NAME 550
SPILLWAY PROFILE
PLATE 7



LEGEND:

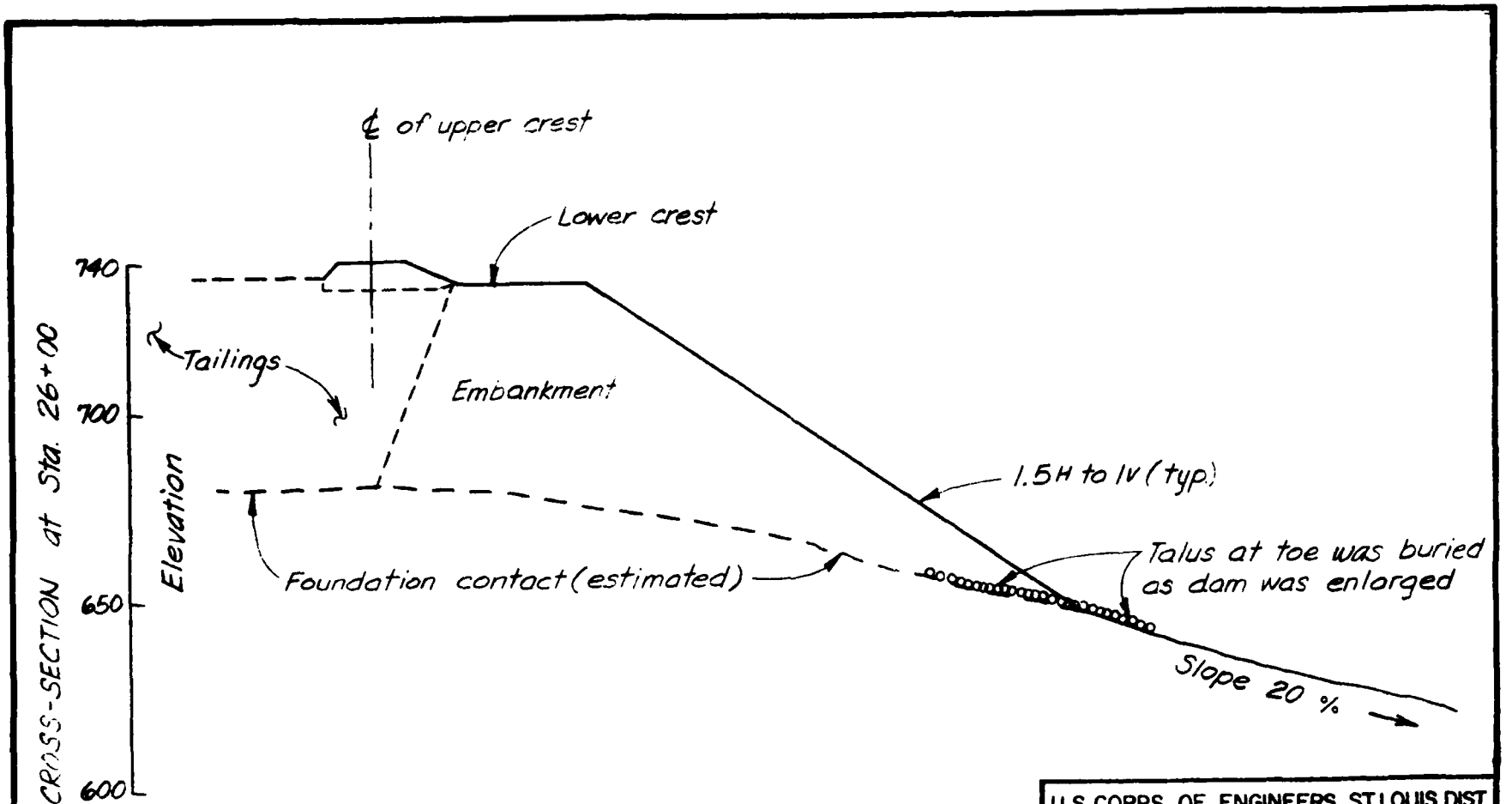
← 4 - Photo No. and view direction

U.S. CORPS OF ENGINEERS, ST. LOUIS DIST.

PHASE I INSPECTION OF DAMS
NO NAME 550 DAM I.D. NO. 30711
PHOTOGRAPH LOCATIONS

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
220 MONTGOMERY STREET, SAN FRANCISCO CALIFORNIA 94104

DESIGNED — INSPECTED —
DRAWN WRV RECOMMENDED —
CHECKED — APPROVED —
DATE 7-24-79
DRAWING NO. PLATE 8



NOTE: Foundation contact and slope were estimated from Tiff 7.5' Quadrangle (1937) and Tiff Orthophotoquad (1975)

U.S. CORPS OF ENGINEERS, ST. LOUIS DIST.

PHASE I INSPECTION OF DAMS
NO NAME 550 DAM I.D. NO. 30711
SECTION AT STA. 26+00

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
220 MONTGOMERY STREET, SAN FRANCISCO, CALIFORNIA 94104

DESIGNED ____ INSPECTED ____
DRAWN W.K.V RECOMMENDED ____
CHECKED ____ APPROVED ____

DATE June 1979
DRAWING NO. PLATE 9

PHOTOGRAPH RECORD

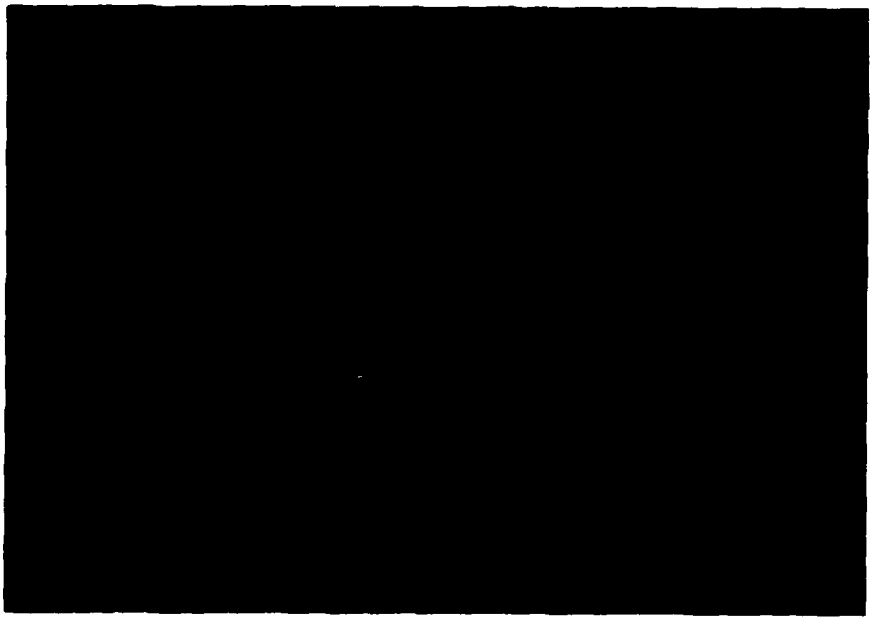
No Name 550 Dam I.D. No. 30711

Photo No.	Description
1	View of downstream slope of embankment and embankment toe.
2	View of two crests of dam near Station 29+00.
3	Crest excavation near Station 24+70. Tailings were observed in the base of the crest excavation.
4	Excavation of downstream slope near right abutment.
5	View of steep ground slope below the embankment near Station 26+00.
6	Crest excavation in vicinity of Station 36+50. Note that no freeboard is available between tailings and the dam crest.
7	Spring at dam toe at Station 28+28.
8	View of dam crest towards right abutment from Station 16+00.
9	View of left abutment from Station 44+50.
10	View of spillway constriction at wing dam Station 1+03 at the right abutment.
11	View of area immediately downstream of wing dam constriction. No well defined channel exists.
12	View of collection area adjacent to the dam where outflow from reservoir will accumulate.

1

2

3



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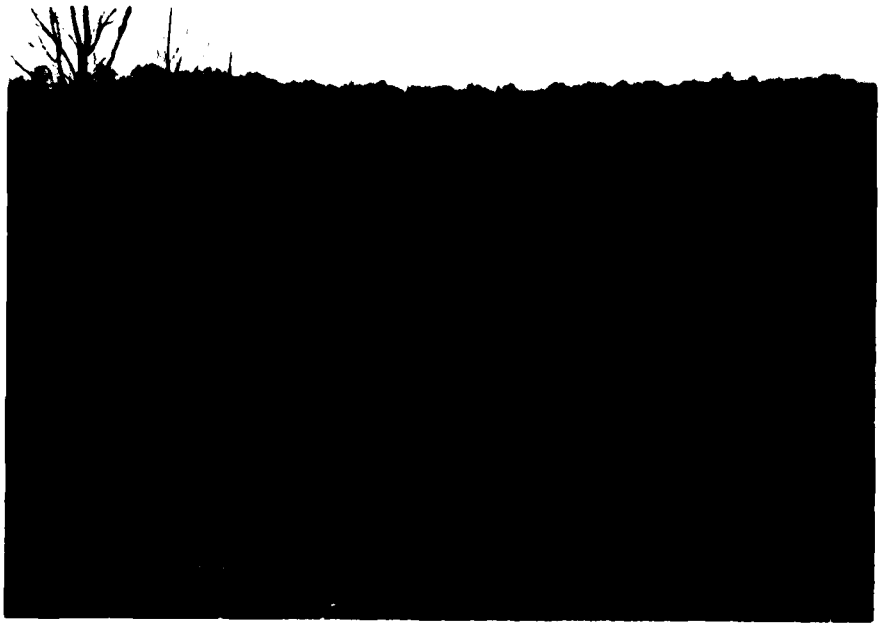

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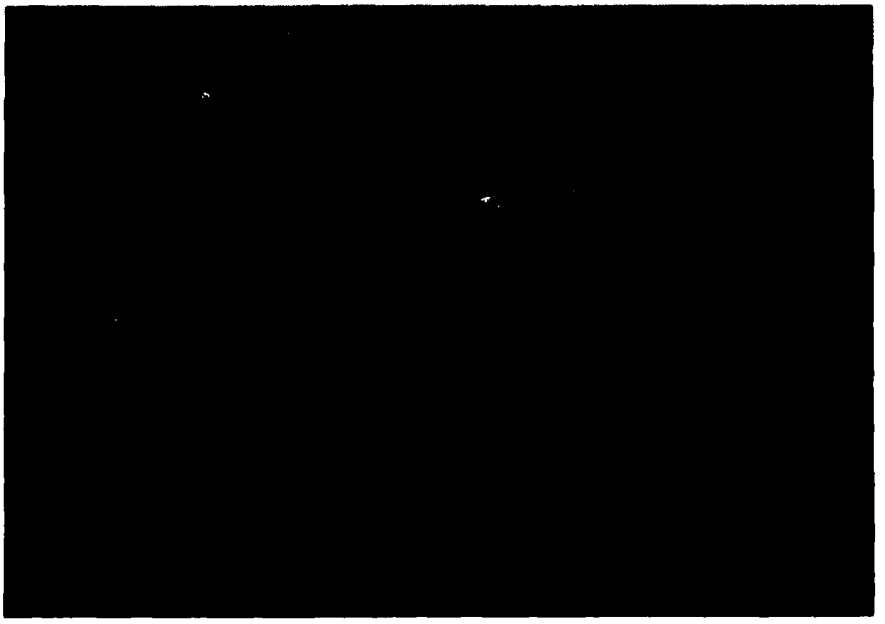

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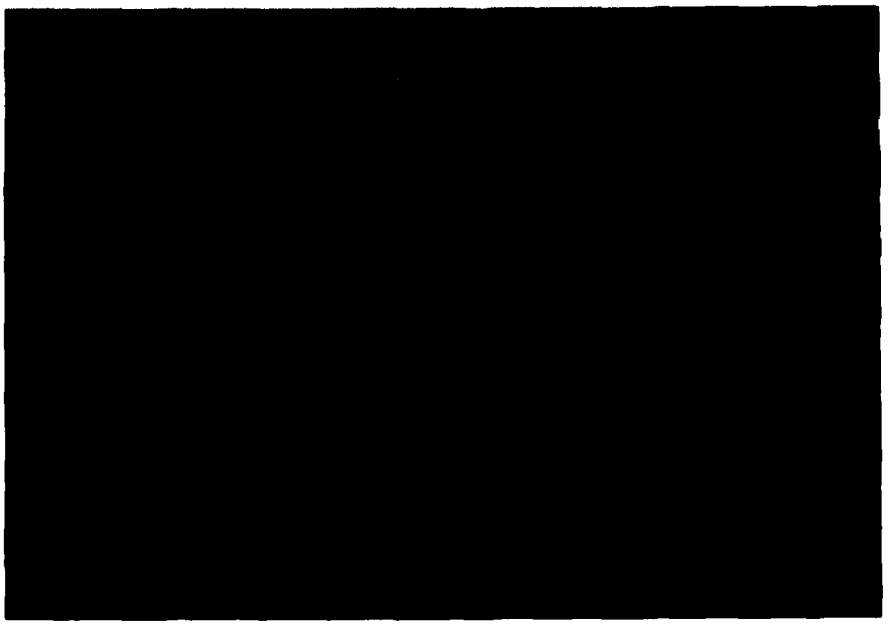
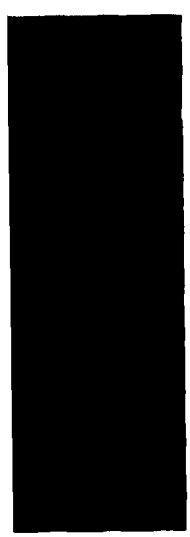


12

DAM PROFILE

PLATE 4C



END

DATE

FILME

11-8

DTIC